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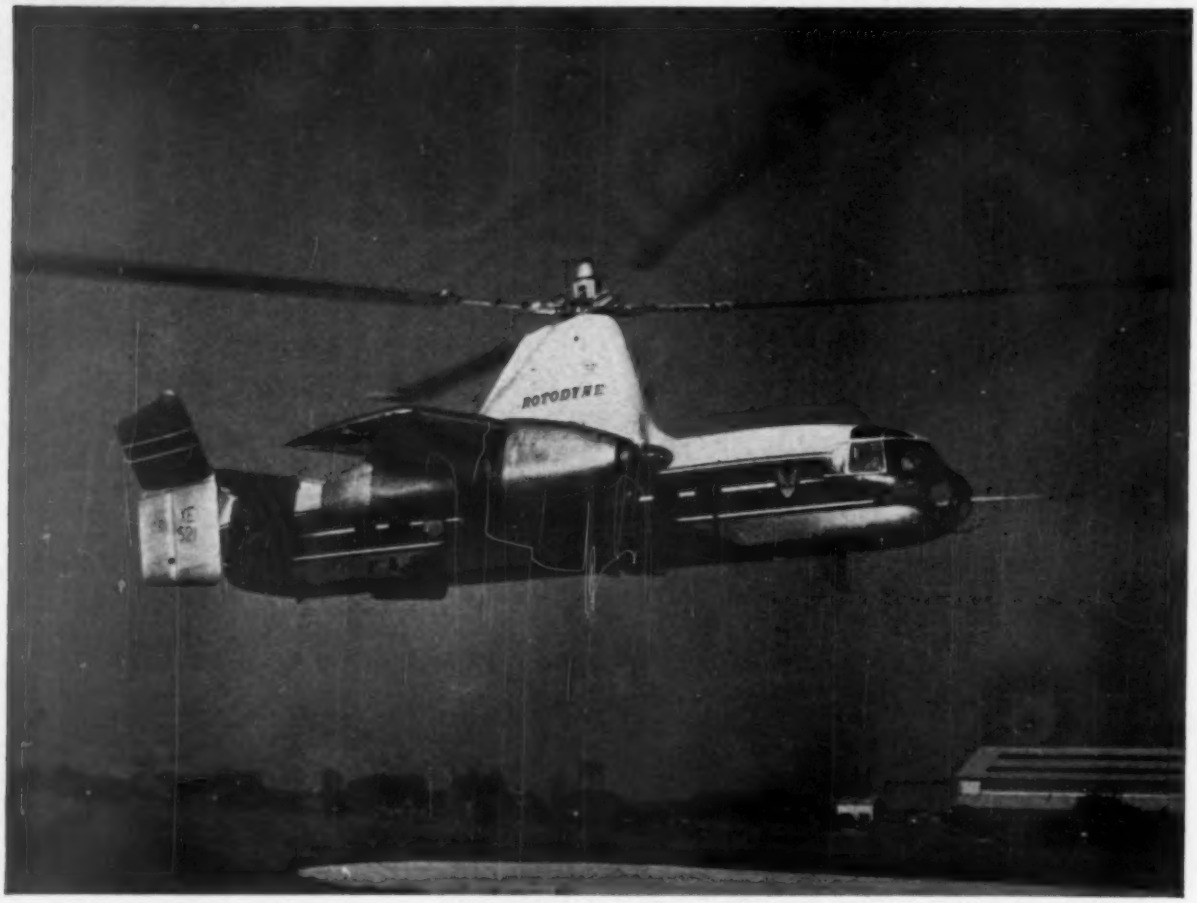

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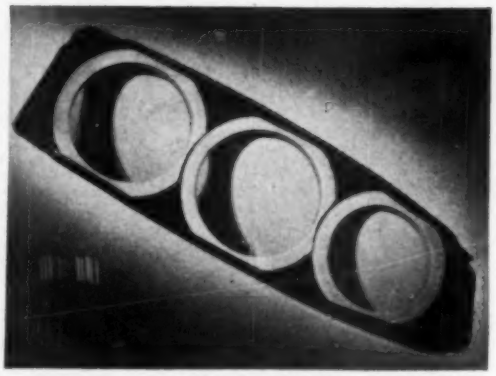

Cross section of blade showing the 'Fluon' rings.

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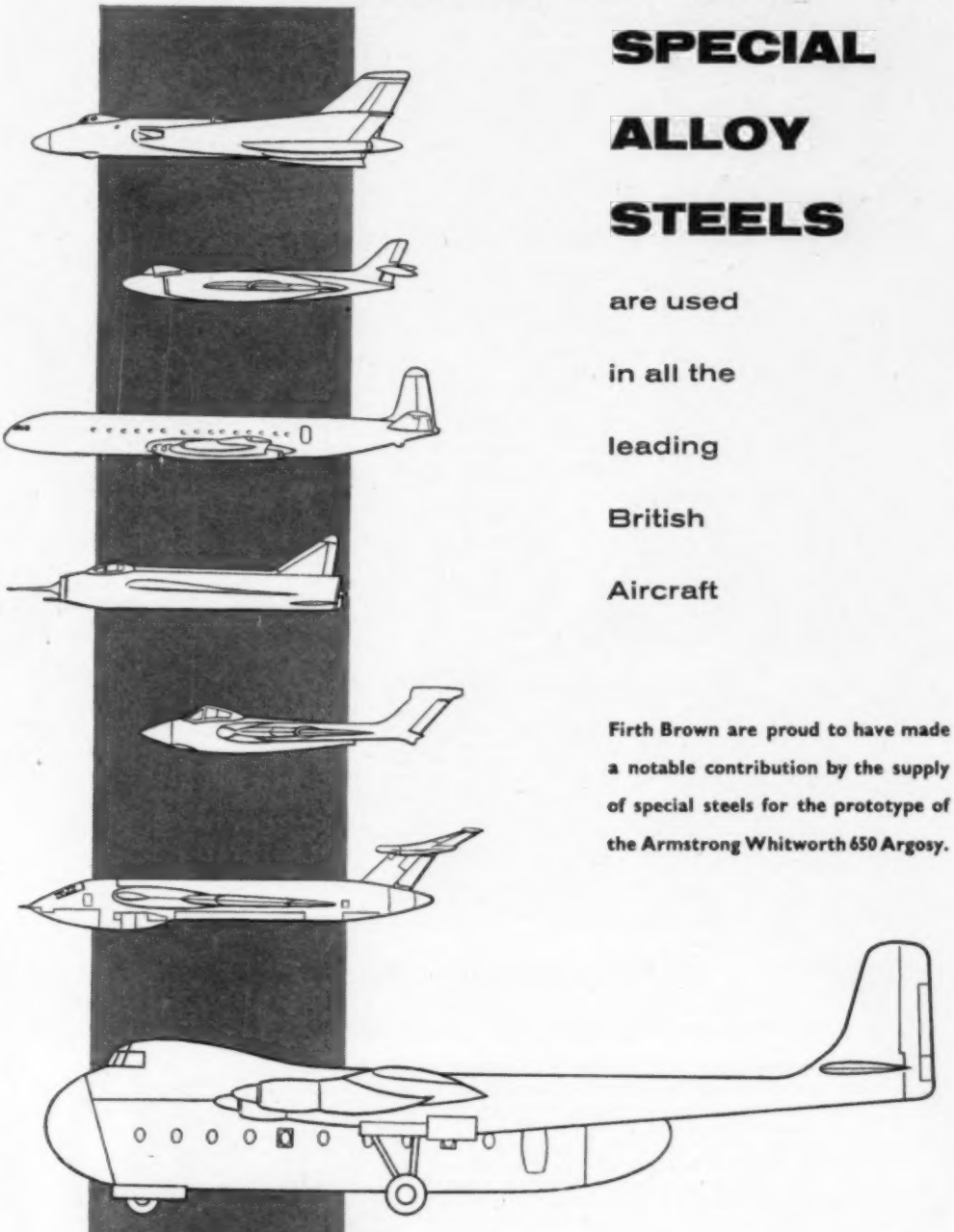

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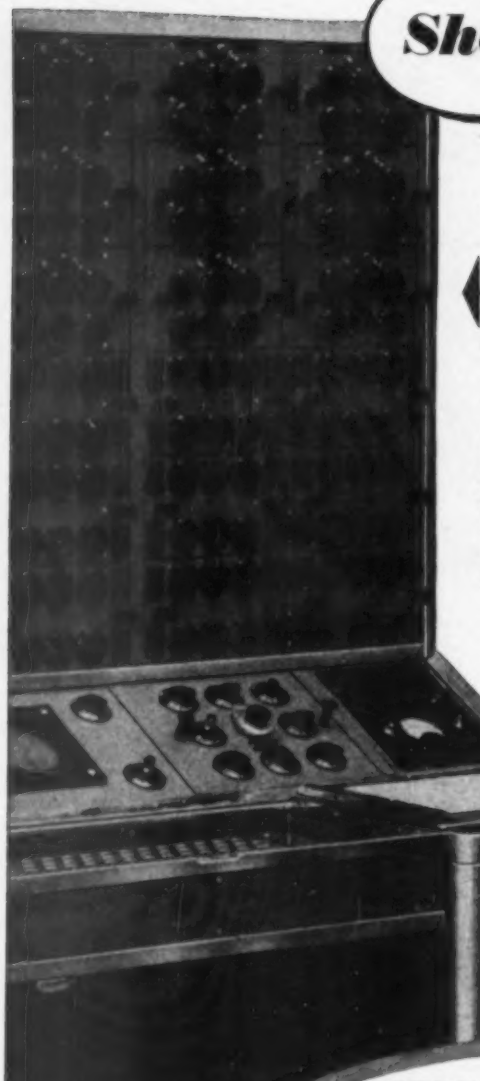

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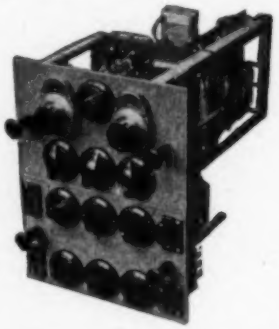

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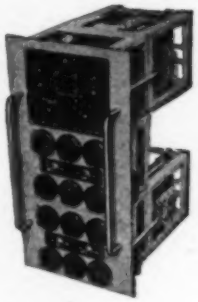

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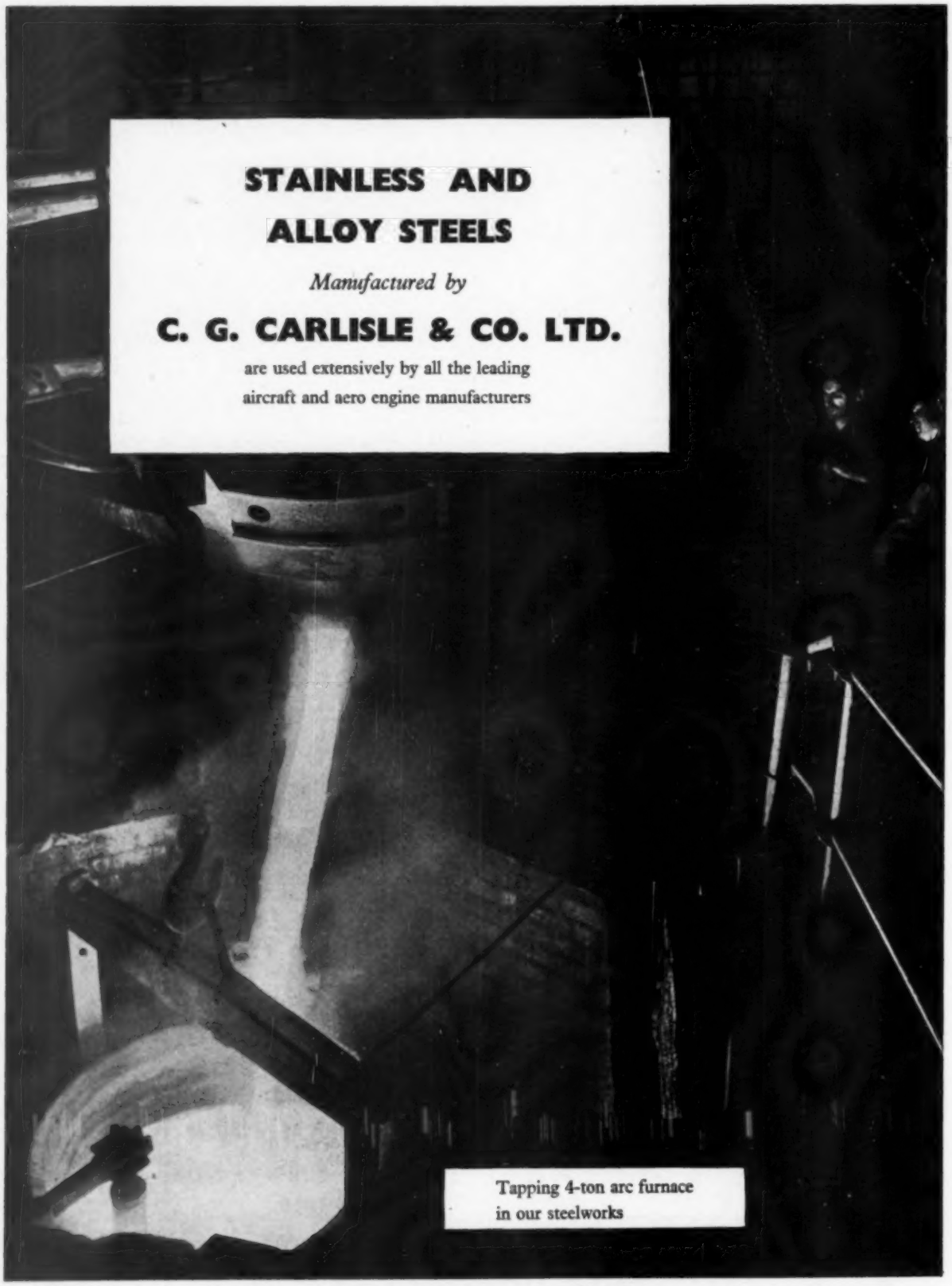

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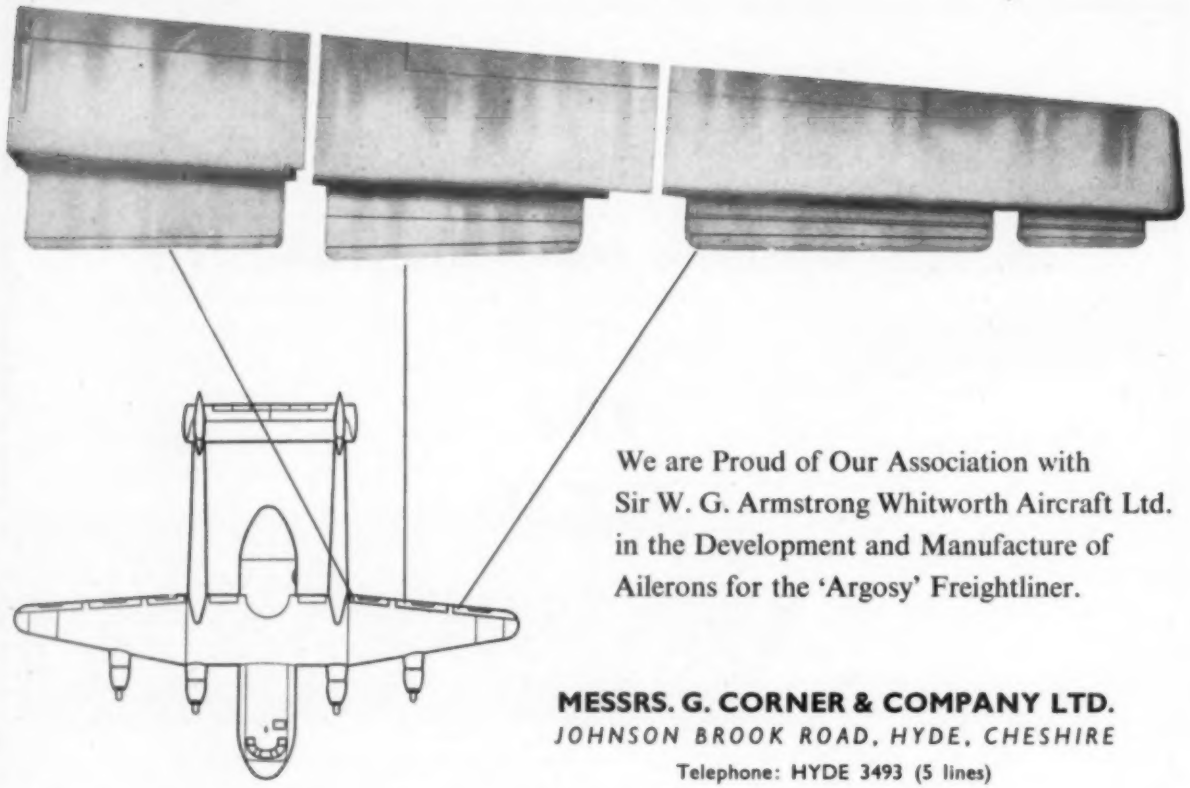

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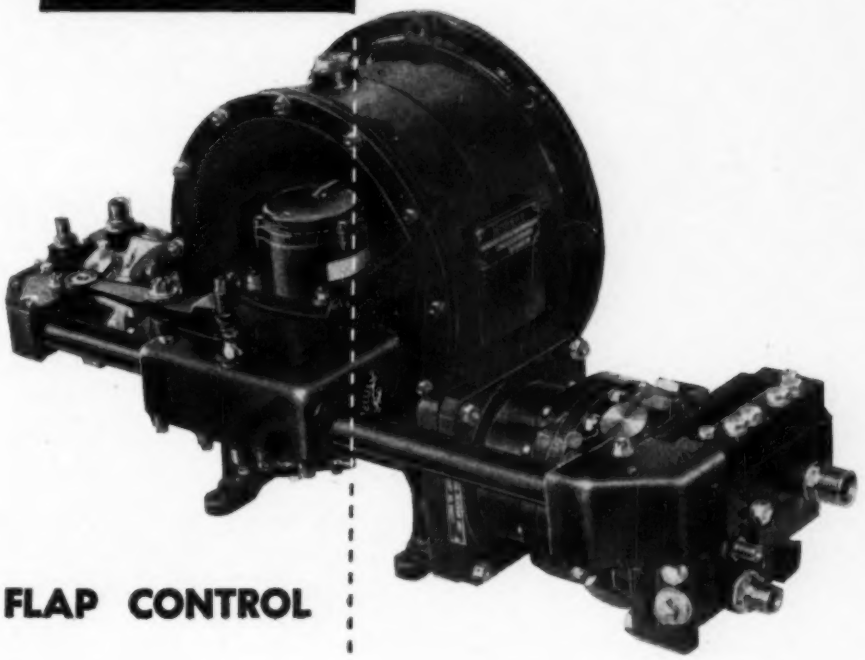

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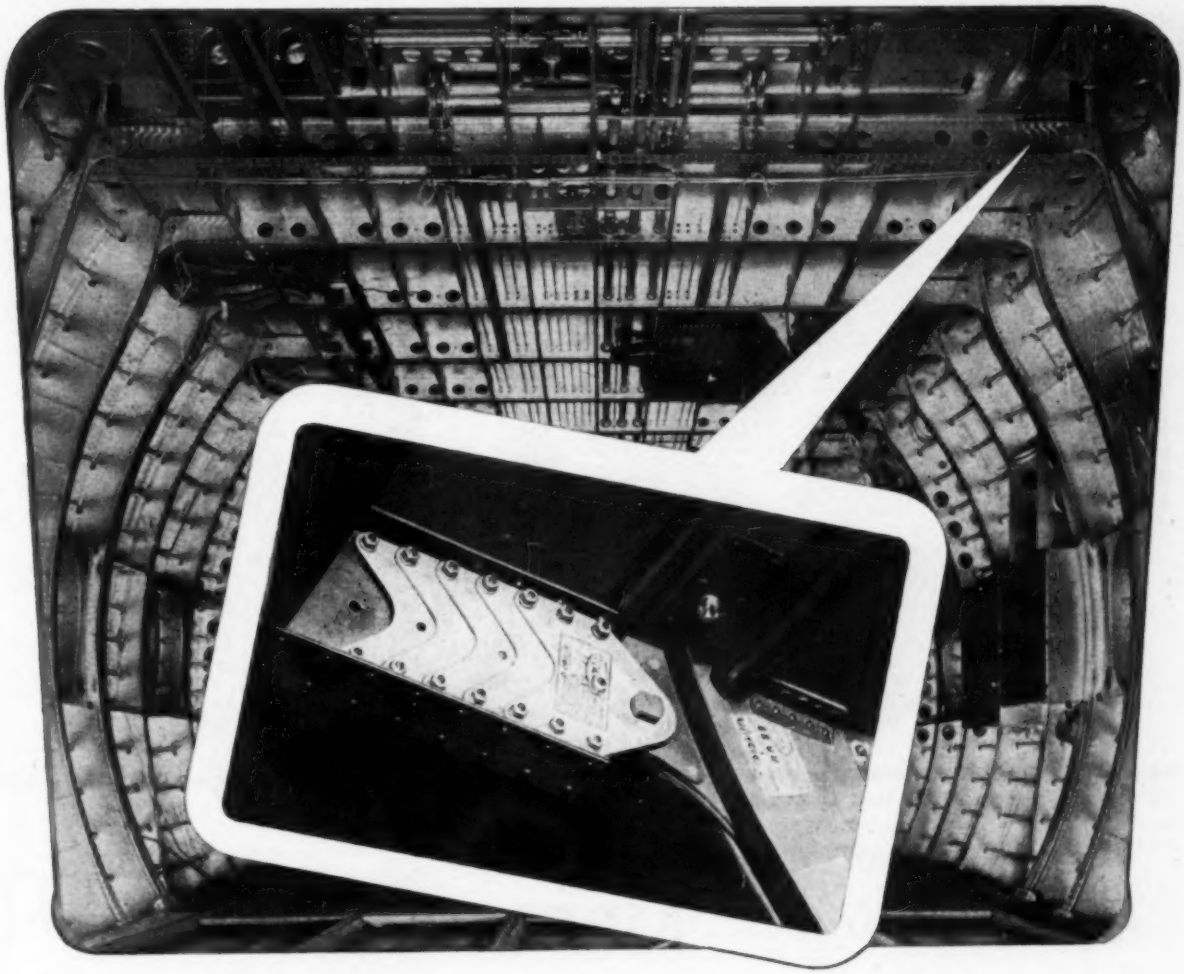

These photographs show the use of Redux-bonded laminated structures in the fuselage of the Argosy.

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The AW Argosy is one of seventy types of aircraft in which Redux bonding has now been employed. By using laminated construction bonded by the Redux process, light metal components may be fabricated to meet exact load requirements. It is then possible to achieve the best possible stress distribution and at the same time to eliminate stress raisers. Strength under static loads is greater than with riveted construction, whilst resistance to fatigue is much improved. Production methods using Redux bonding are relatively simple, and the required variations of thickness are obtained at a much lower cost than by machining. The Argosy also embodies honeycomb sandwich construction, another example of the use of modern materials to save weight and increase payload.

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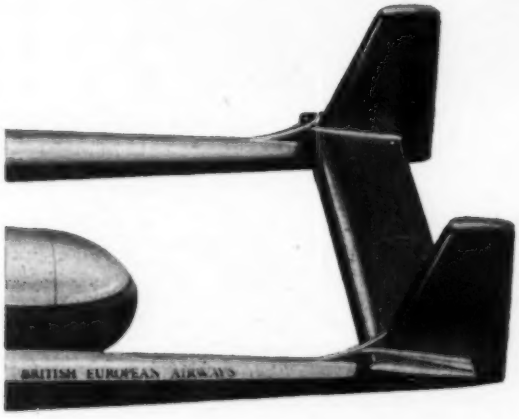
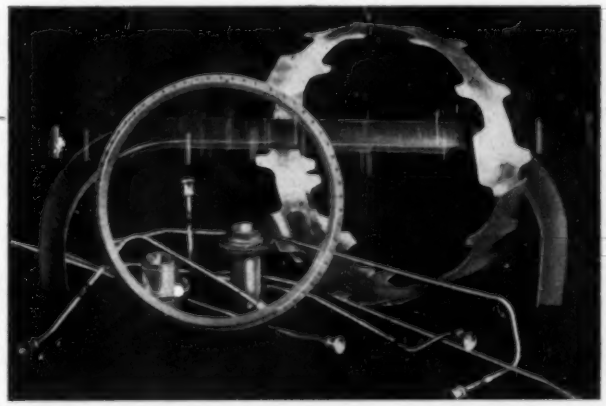


The Armstrong Whitworth Argosy provides a new conception in air freight transport combined with scope for passenger services. In a design which offers immense advantages in speed, economy and payload capacity, extensive use is made of 'Duralumin'. This strong, lightweight alloy is used in many components, including tubing for the aircraft services, bearing housings of flight controls and strip for the construction of the fuselage.

A few examples of components in the Argosy made from 'Duralumin'



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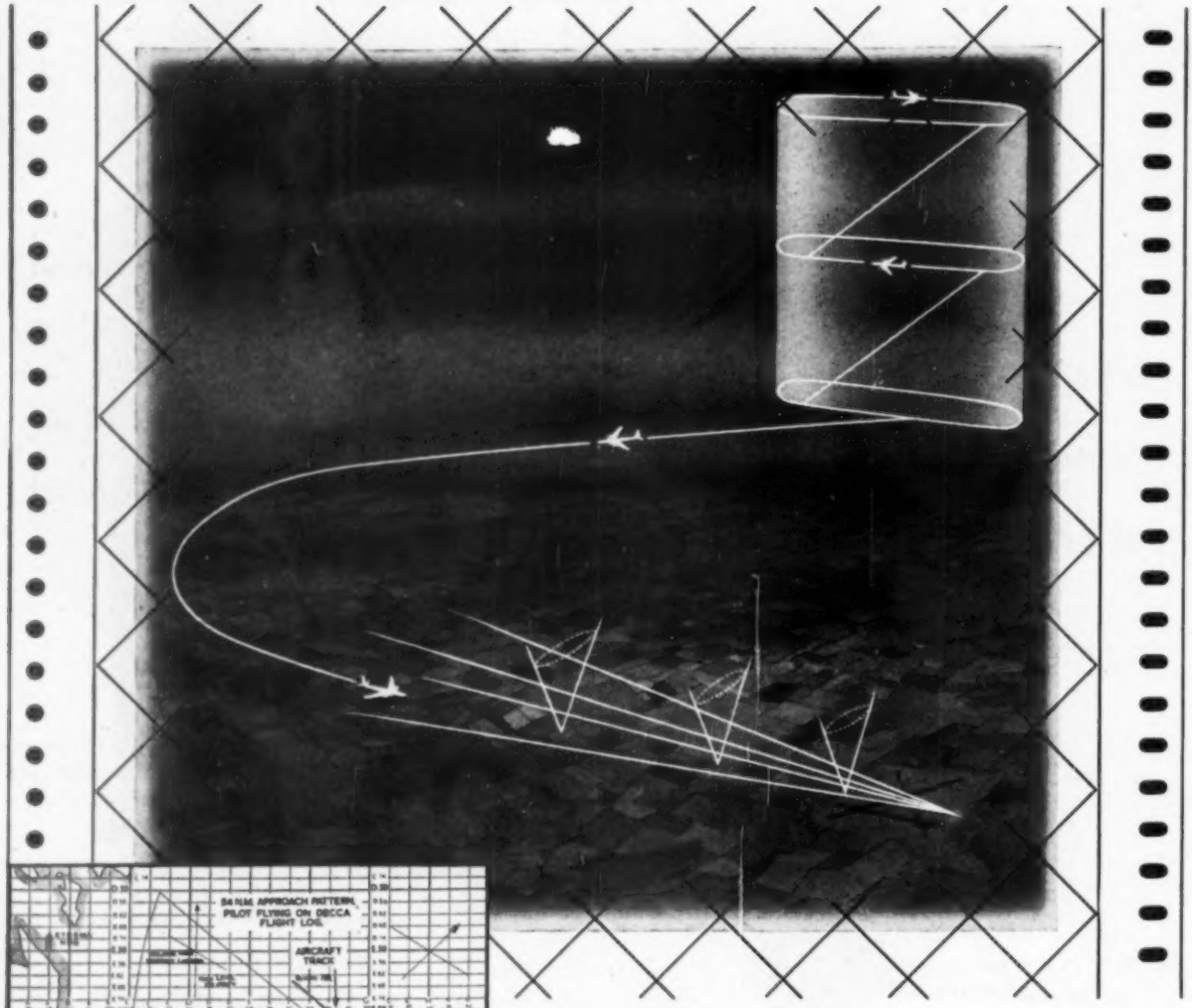

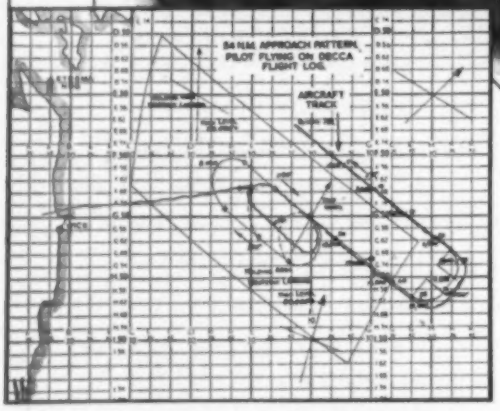

In the trials held off the Orkneys, the holding area and runway were simulated exactly as for London Airport. In the above chart, used during the trials, the holding area with 4, 6 and 8 minute orbits is clearly shown together with the required track to the runway also clearly marked with altitude checks down to the threshold. With the Flight Log the pilot was able to navigate precisely at every stage of the flight, greatly simplifying the entire holding and approach procedure.

Decca in the Jet Age

Recent air traffic control trials carried out by the Ministry of Transport and Civil Aviation in a D.H. Comet have proved that, with the Decca Navigator Flight Log, jet aircraft can be navigated accurately regardless of altitude or weather conditions.

No other aid is either suitable or accurate enough for holding at altitude within a defined area. With Decca, such areas can be designated independently of ground facilities and flown exactly, regardless of drift. Exhaustive tests showed that, with the Flight Log, pilots were able to leave a holding area with a very high degree of precision, track can be maintained precisely during the descent from the holding area to touch down, giving the pilot a continuous check of altitude against distance from touch down.

Knowing exactly where he is at all times by reference to his pictorial display, the pilot has an independent check on radar control, and being able to navigate himself accurately in the terminal area his R/T communication with the ground is greatly reduced. The safety of all aircraft is increased by the consequent lightening of the load on the Radar controller. Improved accuracy in time and position keeping, results in the reduction of delays enabling the maximum landing rate to be achieved.

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FIRST AERONAUTICAL WEEKLY IN THE WORLD FOUNDED 1909

FLIGHT
and
AIRCRAFT ENGINEER

No 2595 Vol 74 FRIDAY 17 OCTOBER 1958

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The Arrow Points a Moral

WHEN this journal presented its description of the Avro Aircraft Arrow on October 25 last year—an account, incidentally, which gave a unique insight into the design and construction of a truly modern supersonic aircraft—the Technical Editor deemed it prudent to close with these words: "So much effort and sound engineering has gone into the programme that it deserves final success, and if the next year is passed without cancellation, then such success should be assured." The year is nearly up, and the programme has not been cancelled; but it has been shaken to its foundations.

In recent weeks the Canadian Government have concluded a review of the defence problems of the North American continent and of the Dominion in particular. Their conclusions were expressed in a statement by Mr. John Diefenbaker, the Prime Minister of Canada. Of the Arrow he said: "Since the project began, revolutionary changes have taken place which have made necessary a review of the programme in the light of anticipated conditions when the aircraft comes into use. The preponderance of expert opinion is that by the 1960s manned aircraft, however outstanding, will be less effective in meeting the threat than was previously expected. It has therefore been decided to introduce the Bomarc guided missile into the Canadian air defence system to be used against hostile bombers. . . . The government has decided that the development programme for the Arrow aircraft and the Iroquois engine should be continued until next March, when the situation will be reviewed again . . ."

As Sir Roy Dobson (managing director of the Hawker Siddeley Group and chairman of A. V. Roe Canada) has pointed out, this does not mean that the Arrow programme has been cancelled. But Mr. Diefenbaker's statement is a very obvious straw in the wind.

Staying in the League

The design, development and production of what, for want of a better term, may be called "advanced" types of aeroplane is today such a vastly expensive business that one nation after another has dropped out of the "Big League" entirely. And once out there is no possibility of getting back. The most that can be attempted is licence construction of an aircraft designed by one of the Big League countries. The list of those countries has dwindled to the U.S.A., Great Britain, Canada, France, Sweden and the Soviet Union, and of these France and Sweden show little sign of intending to stay in the League when the present generation of aircraft is completed. Even in Great Britain the future can be discerned only through a blur of talk about research aircraft, supersonic airliners and a possible bomber called OR.339. Mr. Diefenbaker reasons that "Canada cannot expect to support a large industry developing and producing aircraft solely for diminishing Canadian defence requirements." He might have added that if the Arrow is cancelled Canada will be utterly dependent on the U.S.A. for first-line defence.

If it should be decided to defend the Dominion by Bomarc several aspects would be open to comment. Each missile is a one-shot weapon, and it would be the easiest thing in the world to exhaust a nation's stocks of such devices in a matter of hours. For maximum protection a nation needs missiles *and* fighters. Fighter Command will have the Bloodhound and Lightning and the U.S.A.F. Air Defense Command will have Bomarc and the F-106. It is significant that the North American F-108, the mighty long-range intercepter for U.S.A.F. service from 1963 onwards, still enjoys top priority. Will Canada buy the F-108? In the absence of the Arrow there would appear to be no alternative. As for the Arrow itself, there are many tasks to which it could be put, including some for the R.A.F.

It is easy to examine a programme and say "Twelve and a half million dollars per aircraft is uneconomic. Let's buy from America." But one day Canada may desperately need to design, develop and produce a truly advanced aeroplane; and only then will it be driven home that such a programme is impossible.

MOON ROCKET: A valuable step in the exploration of space was the firing of "lunar probe" Pioneer to a height of almost 80,000 miles last week. Here the Thor-Able three-stage rocket is prepared for launching at Cape Canaveral.

FROM ALL QUARTERS

Towards the Moon

THE second attempt made by the U.S. Air Force to fire a rocket into the vicinity of the Moon was made from Cape Canaveral on Saturday, October 11. Although the attempt was unsuccessful in this object, it produced the deepest penetration of outer space yet made—a distance of almost 80,000 miles, or just over one-third of that to the Moon.

The rocket used, named Pioneer, was an improved version of the Thor-Able unit used in the unsuccessful attempt on August 17, and comprised a Thor IRBM as first stage, a modified Vanguard second stage with eight extra spin rockets, a specially developed solid-fuel third stage, and an 85 lb payload including a solid-propellant terminal rocket and 40 lb of instruments. The entire rocket was sterilized to prevent contamination of the Moon's surface should a direct hit be achieved.

The firing of the three stages gave a maximum velocity of about 23,500 m.p.h. to the payload. This was sufficient for it to escape from the atmosphere, but less than the 24,000 m.p.h. expected. The reason was that the launch angle was 3½ deg too steep and, although extra fuel in the second stage could have made up the speed deficiency, an automatic shut-off device operated when there was still 10 sec of fuel remaining.

Twelve hours after launching, Pioneer was reported to be about 65,000 miles distant and travelling at 3,000 m.p.h. The radio telescope at Jodrell Bank, Manchester, was used to track it during Saturday, when 65 position-fixes were obtained, and Sunday, when over 100 fixes were taken. On Sunday evening the president of the Space Technology Laboratory, California, announced that the rocket was "on its way down" after reaching a maximum height of 79,212 miles (the distance to the Moon was 223,700 miles). Attempts by radio to fire the terminal or retro-rocket in order to change the course of Pioneer had failed.

It had been hoped that the rocket would be established in orbit round the Moon. During Saturday the Pentagon had stated that its instruments were all operating satisfactorily and that "The collection of information on the magnetic field of the Earth, the number of micro-meteorites being encountered in flight, radiation intensity and the internal temperature of Pioneer are being continually received." Also among the instruments was a photo-electric scanner intended to photograph the lunar surface.

On Monday, October 13, the U.S.A.F. announced that the rocket had returned to the Earth's atmosphere "over the South Pacific" early that morning and had presumably been burned up. The time taken for the outward trip of 79,212 miles had been 24 hr, and for the return trip 20 hr.

Croydon Discussion

A DELEGATION from the Aviation Committee of the Royal Aero Club is to meet the Minister of Transport and Civil Aviation, Mr. Harold Watkinson, on Thursday next, October 23, to discuss problems raised by the proposed closure of Croydon Airport (scheduled for December 31). Led by Col. C. F. H. Gough, R.Ae.C. chairman, the delegation will include Capt. T. J. Gunn, Mr. R. E. Hardingham, Mr. J. M. Houlder, Mr. M. O. Imray, Mr. H. B. Lindsay and Mr. P. G. Masefield.

Bristol-Aerojet Agreement

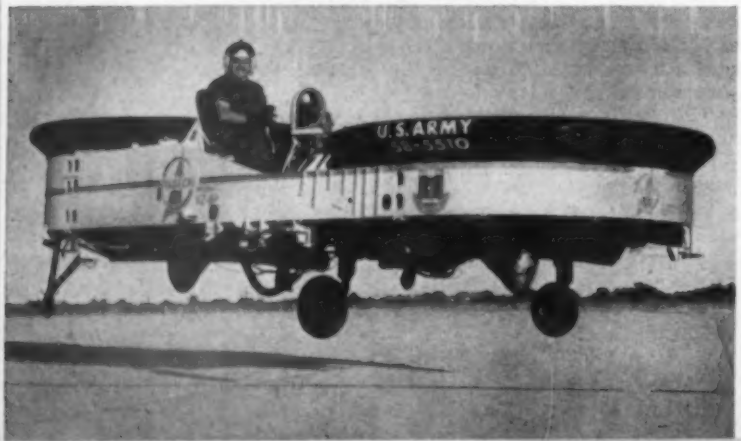
TO be known as Bristol-Aerojet, Ltd., a new company has been formed as the result of an agreement between Aerojet-General Corporation, of Azusa, California, and the Bristol Aeroplane Co., Ltd. In it will be combined the two older concerns' experience in the field of solid-propellant rocket-motor technology.

The new company's plant will be located in England—at Banwell, Weston-super-Mare—and the announcement made by the Bristol company last week says that it "will be devoted to the development, manufacture, casting and testing of solid rocket motors, including propellant formulation." Bristol-Aerojet, the statement continues, "will have the exclusive right to exploit Aerojet solid-propellant rocket products within the field of the agreement in the U.K. and the British Commonwealth. It is probable that the territory covered by the agreement will be extended to include the various friendly European countries."

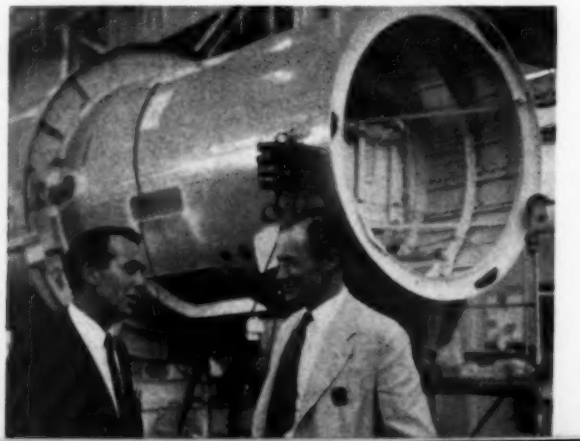
First directors will be: *Nominated by Bristol:* Sir W. Reginald Verdon Smith (chairman, Bristol Aeroplane Co., Ltd.); Rear Admiral Sir Matthew Slattery, C.B. (chairman, Bristol Aircraft, Ltd., and Short Brothers and Harland, Ltd.); Mr. W. Strachan (general manager of the Weston division of Bristol Aircraft). *Nominated by Aerojet:* Mr. Dan A. Kimball (president, Aerojet-General Corp.); Sir Alwyn Crow, C.B.E. (Aerojet's British representative); Mr. W. E. Zisch (vice-president and general manager, Aerojet-General Corp.). Sir Reginald Verdon Smith will be the new company's chairman, and Mr. Strachan its managing director.

A subsidiary of the General Tire and Rubber Co. since 1945, the Aerojet business was started in 1942 by Dr. von Kármán, the renowned aerodynamicist. Originally concerned with the development of Jato units, it is today the world's largest company engaged in the manufacture of solid-propellant rockets for

MR. FRANK PIASECKI is here seen flying his company's first VZ-8P "aerial jeep" at Philadelphia. Built to an Army research contract, it has two ducted rotors with diametral control surfaces.



MR. DUNCAN SANDYS, British Minister of Defence, was recently shown the Thor IRBM line at Douglas Aircraft, Santa Monica, by Mr. Donald W. Douglas, Jr. He also saw R.A.F. men on a Thor course.



missiles and aircraft. Probably the most important of their current programmes is that for the propulsion of Polaris, the U.S. Navy ballistic missile.

Bristol's rocket work includes the manufacture of motor cases for the majority of British guided weapons, ranging from anti-tank rockets to the big Raven units which power the Skylark high-altitude research vehicle.

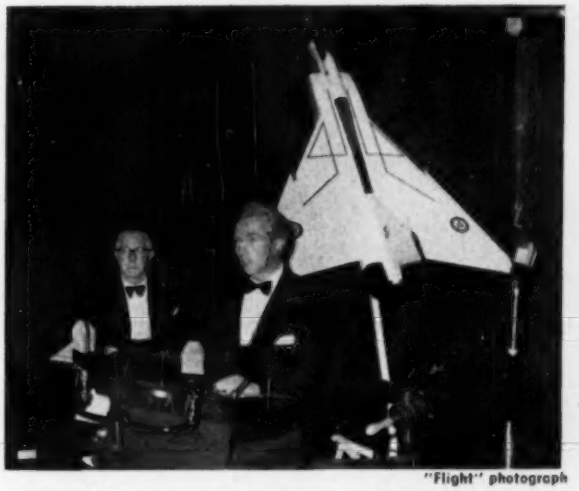
Not High Enough

A THIRD balloon ascent in the U.S.A.F.'s "Man High" series was made in New Mexico on October 8. A plastic balloon containing 27,000 cu ft of helium—which would expand at altitude to some 3m cu ft—was employed; and the pilot, Lt. Clinton McClure, was sealed in a 9ft×3ft air-conditioned cylinder. He entered it over five hours before take-off, its pressurization then being gradually reduced to a 24,000ft equivalent to lessen the risk to the pilot in the event of a leak developing.

The intention was to ascend to 20 miles (105,600ft) and remain at that altitude for 24 hours while transmitting an elaborate series of observations. In the event the balloon approached within a few hundred feet of its target height, but the atmosphere in the gondola then became unbearable through heat and humidity, forcing McClure to descend.

This was doubly bad luck for the pilot. On the previous day he had undergone the acclimatization process to no purpose, as a rising wind made the vast envelope unmanageable shortly before launching. It was deliberately destroyed, and another substituted.

In the first "Man High" effort, in June 1957, Capt. Joe Kittinger reached 96,000ft; the second, ten weeks later, took Maj. David Simons to 102,000ft, at which altitude he remained for 32 hours.



"Flight" photograph

***TALKING-POINT:** Mr. J. C. Floyd, vice-president engineering, Avro Aircraft, Ltd., delivering his Commonwealth Lecture on the Arrow (see page 573 last week) before the R.Ae.S. With him is Dr. E. S. Moult, director and chief engineer of the de Havilland Engine Co., deputizing for the Society's president, Sir Arnold Hall.*

IN BRIEF

With the commissioning of No. 807 Sqn. (Lt-Cdr. K. A. Leppard) at R.N.A.S. Lossiemouth on October 1, the Royal Navy now has two operational Scimitar squadrons. No. 807 will be ready to go to sea before No. 803 has finished its tour in H.M.S. *Victorious*; and the new squadron may be going to *Ark Royal* or *Eagle*.

* * *

B.M.W. Triebwerkbau of Munich has purchased an option to build the Bristol Orpheus under licence. Agreements already exist for the manufacture of this engine in Italy, France and India.

* * *

One of the fastest Comet transatlantic flights to date was made on October 8 by an R.C.A.F. Comet 1A (D.H. Ghost engines). Carrying Service personnel between Montreal and Hatfield *en route* for France, it crossed from Gander to Shannon in 3 hr 36 min, a speed of some 550 m.p.h.

* * *

A Victor of R.A.F. Bomber Command flew from Gaydon in Warwickshire to Goose Bay, Labrador, in 5 hr 14 min on October 10—covering the 2,242 miles at an average speed of 428 m.p.h., against head winds at times reaching 115 m.p.h. The captain was S/L. A. W. Ringer and the co-pilot the A.O.C. No. 3 Group, A.V-M. K. B. B. Cross, who was on his way to March A.F.B. (Cal) for the S.A.C. bombing and navigation competition.

* * *

Mike Lithgow, Vickers-Armstrongs deputy chief test pilot, has been trying out various American high-performance aircraft at the Naval Air Test Center, Patuxent River, Md. His first was the Chance Vought F8U-1 Crusader. After brief familiarization, says a report, he "pushed it far beyond Mach 1," and on a second flight the same day "climbed from a Dallas Naval Air Station runway and roared out of sight, straight up to 50,000ft, with afterburner blazing."

* * *

A conference on *The Link Between Schools and Industry* is being held by the Gloucestershire Industrial Education Council at Cheltenham Town Hall on October 21 and 22. Among the speakers will be Mr. G. G. Roberts, M.Sc., A.F.R.Ae.S., technical director of Smiths Aircraft Instruments, Ltd., and Waymouth Gauges and Instruments, Ltd.; Dr. F. E. Jones, M.B.E., B.Sc., Ph.D., M.I.E.E., A.F.R.Ae.S., technical director of Mullard, Ltd.; Mr. E. J. Nicholl, B.Sc., F.R.Ae.S., joint managing director of Dowty Equipment, Ltd.; and Mr. M. B. Morgan, C.B., M.A., F.R.Ae.S., deputy director of the R.A.E. Farnborough. In addition to the conference, the council is holding an exhibition (from October 21 to 25, in the Imperial Gardens adjoining the Town Hall) on the theme *Opportunities in Engineering*.

* * *

Brigadier L. L. Cross, C.B.E., Chief of Public Relations at SHAPE since 1954, has been appointed public relations officer to the Hawker Siddeley Group.

* * *

G/C. A. C. P. Brightmore has been appointed Director of Electronics Research and Development (Air), Ministry of Supply, with the acting rank of air commodore. He succeeds A. Cdre. C. A. Bell.

* * *

Exclusive selling rights in the U.S.A. for all aviation products of Smiths Aircraft Instruments and their associated companies have been granted to Vickers-Armstrongs, Inc., of Arlington, Virginia.

* * *

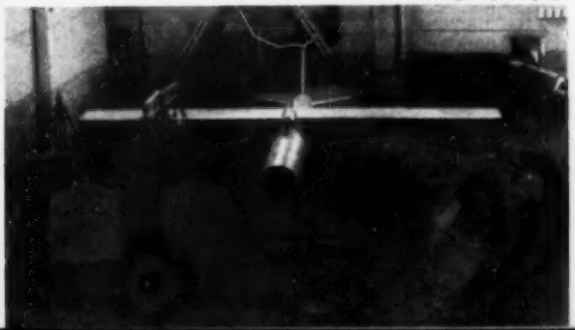
Three appointments announced by D. Napier and Son, Ltd., are those of Mr. W. E. Hampton, A.F.R.Ae.S., as deputy commercial manager (aviation); Mr. M. Lowe, C.B.E., as aviation sales manager (U.K. and Europe); and Mr. A. G. Shove, A.F.R.Ae.S., as aviation sales manager (overseas).

* * *

The pilot of a Canberra PR.9 which fell into the sea ten miles off Blackpool ejected successfully and was picked up, suffering from shock and minor injuries, by a fishing vessel. He was Donald Knight, an English Electric experimental test pilot. Intensive search failed to find his observer, P. H. Durrant.

* * *

First flight of the Pushpak, an ultra-light two-seater designed and built by Hindustan Aircraft at Bangalore, was made on September 24. Powered by an 80 h.p. Continental, the prototype is to be followed by a production version powered by an Indian-built engine. With a span of 36ft, empty weight 830 lb and gross weight 1,350 lb, the Pushpak has a cruising speed of 90 m.p.h. and is expected to cost about 20,000 rupees (£1,500). Construction of the prototype began on August 7 this year and the completed aircraft was ready for ground trials six weeks later.



"Flight" photograph

***FIRST APPEARANCE:** Obviously several years old, yet on public view for the first time last week—at the Open Days of the College of Aeronautics, Cranfield—were (left) the Vickers Supermarine Type 545 and (below) an anonymous guided-bomb missile. The latter is presumably a cancelled project, the identity of which may not be divulged.*

A Fireflash accelerates away from a Swift F. Mk 7 on the Aberporth range. After two seconds the boost motors separate at over Mach 2.

FIREFLASH PROGRAMME

SERVICE TRIALS AT R.A.F. STATION VALLEY

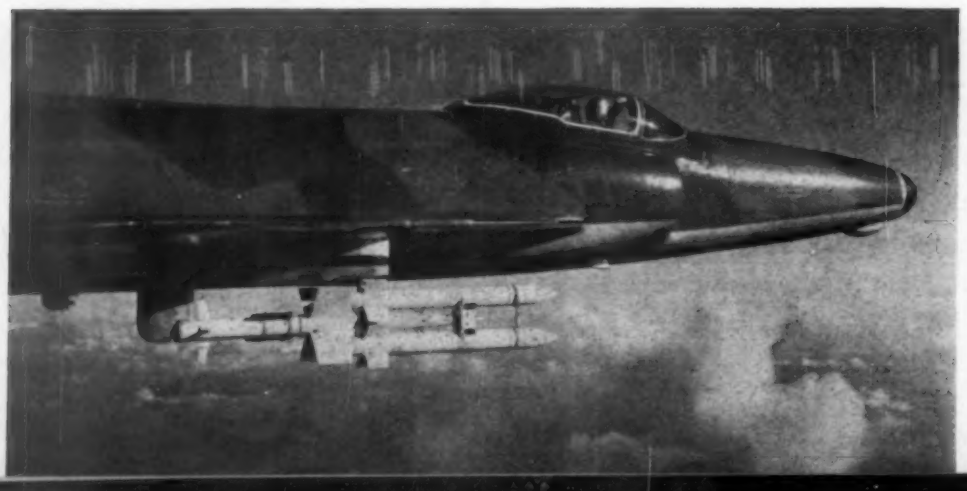
FOR the past eighteen months the Royal Air Force has been accumulating experience in the squadron use of air-to-air missiles at R.A.F. Station Valley, in Anglesey, where No. 1 Guided Weapon Development Squadron (W/C. J. O. Dalley) has been flying Swift F. 7s and carrying out a planned programme of Fairey Fireflash firings over the Aberporth range. At least 40 Fireflashes were to be seen in various stages of preparation and storage during a visit last week and a demonstration firing was made alongside a Hastings.

Since Fireflash is not destined for general service, the trials are not intended to prove or disprove this weapon but rather to give a Service squadron the experience and know-how they will require when the later Firestreak comes into service with G.W.D.S. next year. Though each Fireflash firing may at present cost several thousand pounds, the G.W.D.S. programme has in fact saved much more money by allowing the Service to finalize all the number drills and installation requirements for missile handling. Each Fireflash carries a telemetry head which transmits some 24 channels of information on its behaviour. The actual results of testing, assembly and storage can thus be assessed; and two scientists are collecting statistical data for future reference.

Fireflash has proved accurate, easy to use and lethal—though, because of the expense involved, very few drones have been deliberately destroyed. The firings are generally made with the target out of range, the telemetry results showing whether success would have been achieved.

The sequence of Fireflash handling has now been established as follows. The dart, its boost or "stork" motors and the wings and fins arrive in shockproof packings and are taken to the electronic check-out laboratory. There the interior components are extracted from the dart to be fitted with potted batteries, while the wings are screwed to the cylindrical body. The weapon is then assembled with fins and placed on the "oats" table (Operational Airfield Test Set) for a complete "go-no-go" check with the missile rolling and turning on its mounting. Electrical, gyro air, cooling air and servo air supplies are connected. The assembly next receives its telemetry head and goes to the telemetry test cradle where operation is checked by actual transmissions to special receivers in another room.

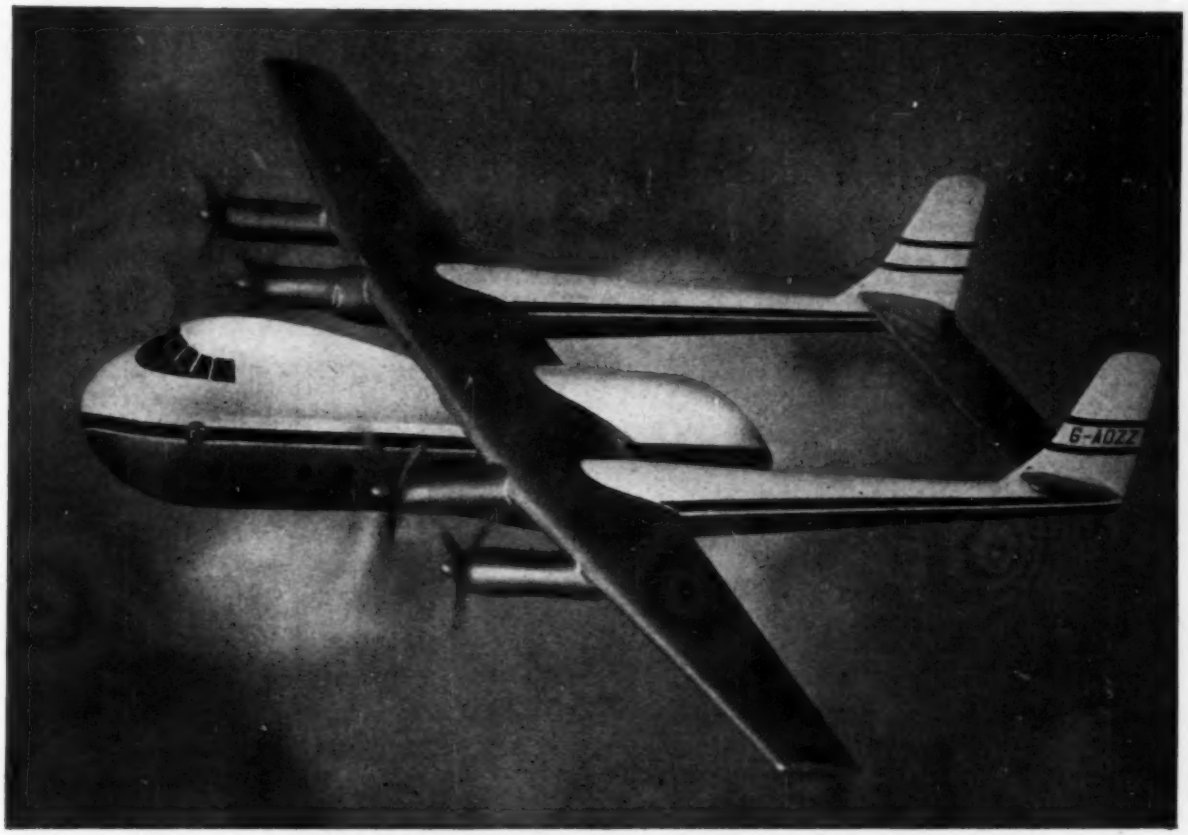
The completely checked darts are taken to the fenced-off



In this closest of close-up views, the two-point Fireflash attachment and disposition of boost motors above and below the free-flying missile "dart" can clearly be seen.

ARMSTRONG WHITWORTH

ARGOSY



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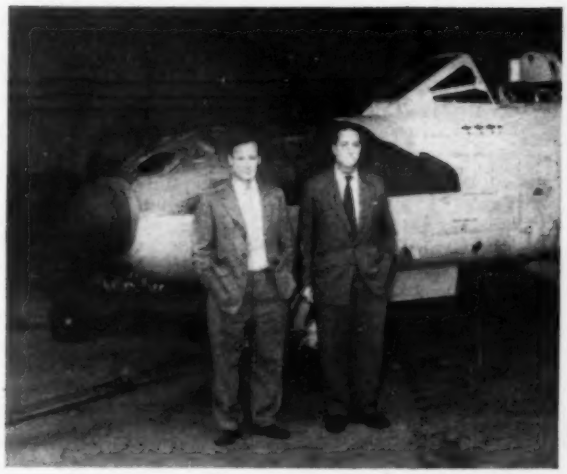
TEST AT M.I.R.A. PROVES QUICK STARTING WITH CASTROLITE

MOTOR INDUSTRY RESEARCH ASSOCIATION

In a recent test at the Motor Industry Research Association's establishment at Lindley, a Morris Minor was frozen in the cold chamber for 24 hours at a temperature of 30° below freezing. With Castrolite, the balanced multi-grade oil in the sump, it started first pull on the starter. The practical demonstration of this is being shown on all ITV channels during the winter months.

Don't take chances - ask for CASTROLITE by name

THE BALANCED **MULTI-GRADE** MOTOR OIL



"Flight" photograph

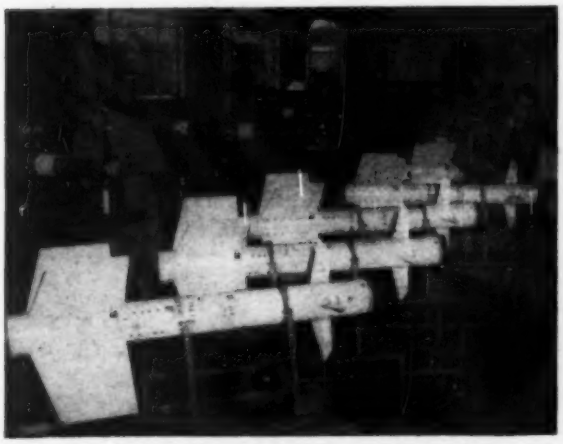
Mr. I. R. Ryall and his flight observer, Mr. P. H. Clark, stand beside the Meteor NF.11 from which they made the first Fireflash firing during the summer of 1951.

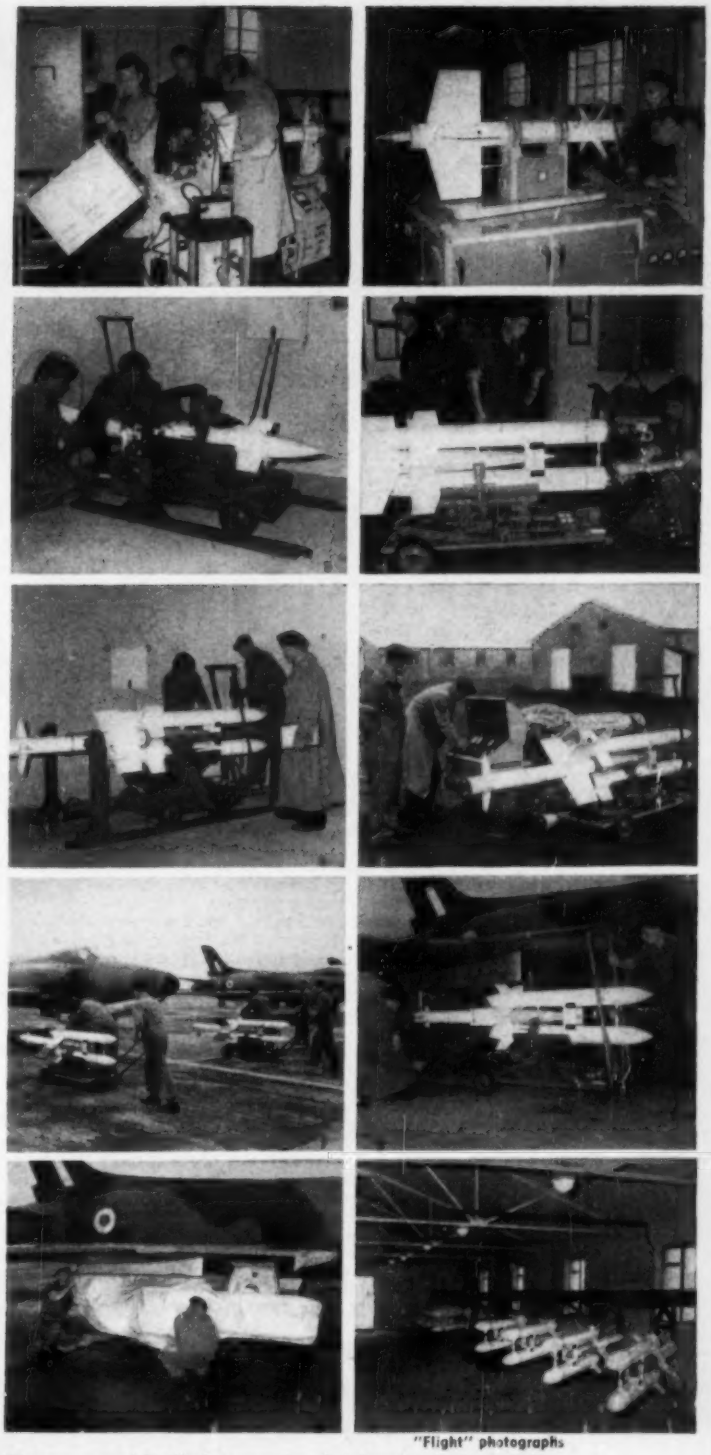
explosives area, which is safeguarded by stringent regulations and drills. Here the boost motors are individually checked for electrical integrity before being assembled to the missile on a universal transporter trolley, and final electrical checks of fusing and firing circuits are made with photo-electric voltages. During checking the assembly is isolated on an anchoring stand. Brick huts are specially designed to dissipate blast from accidental explosions, and assembly rooms have special doors to allow rapid escape in case of trouble. Following this the complete, checked missiles are mounted on racks in warmed storage rooms until required. They can alternatively be stored in special cases in the open.

Before Fireflash is loaded on the aircraft, the pylons and firing circuits are checked according to a precise drill. The missiles, on their universal trailers, are then run up to the pylons and secured according to further strict drills. After that they can be left *in situ* under special fabric covers. The aircraft is treated as if it had loaded guns.

Range work is under close G.C.I. control, though an audio tone normally tells the pilot when he is at correct firing range. After that he holds the guiding beam on target with a visual sight and tracks it accurately for the five seconds or so of missile flight-time. The boost motors separate after two seconds, by which time the missile is travelling at a speed higher than Mach 2.

Incidentally, the first Fireflash firing was made from a modified Meteor NF.11 in the summer of 1951 by Mr. I. R. Ryall of Fairey, who now manages the site for the R.A.F. His observer was Mr. P. H. Clark. The G.W.D. squadron is in fact a Central Fighter Establishment unit coming under the direction of the Group Captain Operations, G/C. W. Pitt-Brown.

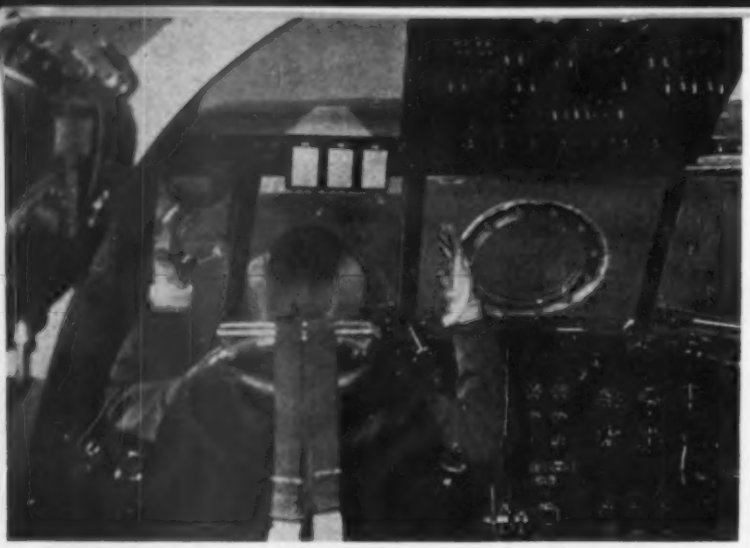




"Flight" photographs

The sequence of Fireflash preparation: 1, telemetry checking; 2, "go-no-go" checking of the headless dart; 3, boost motor electrical test; 4, boost motor final assembly and test; 5, final checks with photo-electric voltages, the missile mounted on its universal trolley; 6, topping-up nitrogen for the servos; 7, approaching the aircraft in drill sequence; 8, final connection before removing wing guards; 9, storage on the aircraft; 10, storage in heated rooms.

(Left) The electronic check-out laboratory where the dart of Fireflash is unpacked, assembled and fully checked before joining with its boost motors.



"Look, no hands" during an automatic approach to R.A.E. Bedford in a Varsity of the Blind Landing Experimental Unit.

British Automatic Landing System

NOW taking place at R.A.E. Bedford is an important two-day demonstration before representatives of the Services, M.T.C.A., M.o.S., British airlines and Pan American Airways. The Blind Landing Experimental Unit is showing for the first time the complete British automatic landing system developed since World War 2.

B.L.E.U. work has reached the stage where all is ready for the preparation of an air-transport installation in final form. Some 2,000 successful (and damage-free) automatic landings have been made in both jet- and piston-engined aircraft using equipment which is already largely in airline use. The extra equipment required weighs about 100 lb, but with certain improvements in the accuracy of present I.L.S. ground equipment—and this has already been undertaken—the extra load could be significantly reduced. Actual introduction into service now depends mainly on the operators' and manufacturers' specific requirements in terms of safety devices and upon international agreement on the exact specification of certain ground equipment.

It is particularly significant that B.O.A.C. have decided to introduce automatic flare-out as part of the triplicated flight-control system of the VC.10. Full automatic landing could later be added. The B.L.E.U. equipment now has a single channel whose safety relies on built-in in-flight checking facilities, visual monitoring by the pilot on integrated instrumentation and a positive indication of the take-over of each successive element in the automatic sequence. It is now installed in Devon, Varsity and Canberra T.4 aircraft, and consists of a Smiths S.E.P.2 autopilot, normal I.L.S. receiver, Standard Telephones STR.30B high-accuracy radio altimeter, Murphy leader-cable receiver and Smiths automatic throttle control. On the ground are normal I.L.S. (in this case by Pye) and Murphy leader cable. The last-named consists simply of two airfield lighting cables laid 250ft each side of the runway centre-line from a suitable point beside the runway to a point 5,000ft out from the threshold. A 4 amp current is passed through these cables at 1,000 c/s on one side and 1,700 c/s on the other, the frequencies being electronically stabilized and fault-monitored. A small partially transistorized receiver in the aircraft receives signals from the cables through a rotating loop mounted under a small dielectric dome located either at or near the extreme nose of the aircraft. The ratio of the strength of the two signals is assessed to determine the position of the aircraft to an accuracy of ±5ft. The leader cables themselves can be buried, laid along the ground or strung on poles and the transmitter can be remotely controlled over G.P.O. lines. Airborne receiver and loop weigh 16 lb.

The STR.30B reads accurately to within 2ft and operates from 0-5,000ft and 0-500ft. The Smiths Flight System instruments are standard, but the S.E.P.2 navigation computer and locking box are modified. Automatic throttle control was specially developed by Smiths to control the engines according to A.S.I. error signals and attitude demand signals. Very little "tailoring" has been required to make the system fit a wide variety of aircraft types.

A new aerial system could be developed for the present I.L.S. ground equipment to improve localizer accuracy from the present 0.3 deg to 0.01 deg, rendering it sufficiently accurate for automatic landing. Glide-path accuracy down to 50ft could similarly be improved, and this would eliminate the need for leader cable and the "attitude" phase described below. But such progress must await international approval and negotiations have begun.

A *Flight* representative flew through several automatic landings in a Canberra T.4 and noted touch-down at about 1ft/sec descent within 30ft of the designated point each time. He particularly noticed the smooth control throughout and the ease of operation.

A B.L.E.U. automatic landing is divided into phases called track, glide, leader cable, attitude, flare-out, drift correction, touch-down and ground run. First, the aircraft is set to fly at about 1,000ft on autopilot, using barometric height lock. A turn is made and the track control operated to initiate I.L.S. localizer capture. The aircraft settles on the beam and comes up to the glide-path, as indicated by the I.L.S. horizontal pointer. The throttles are automatically controlled to give a preselected approach speed with wheels and flaps down.

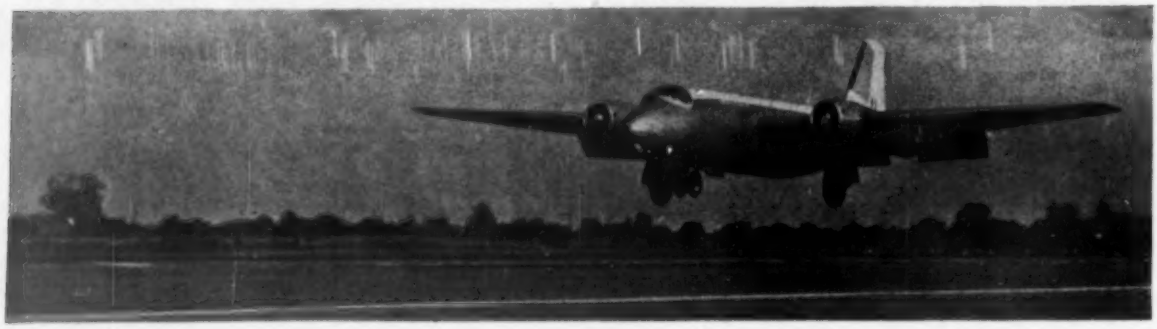
Still following standard automatic-approach practice, the pilot selects glide-path to the autopilot and at any moment from here down to a height of 600ft he may prime his automatics and elect to make an automatic landing. He has 1½ min in which to decide. The radio altimeter begins to read at 500ft above ground (if it is inadvertantly left in the 0-5,000ft range it automatically reverts to 0-500ft). At 300ft, leader cable automatically takes over azimuth guidance from I.L.S. localizer. Glide-path and automatic throttle continue working, but leader cable signals now control the relevant indications on the Flight System instruments.

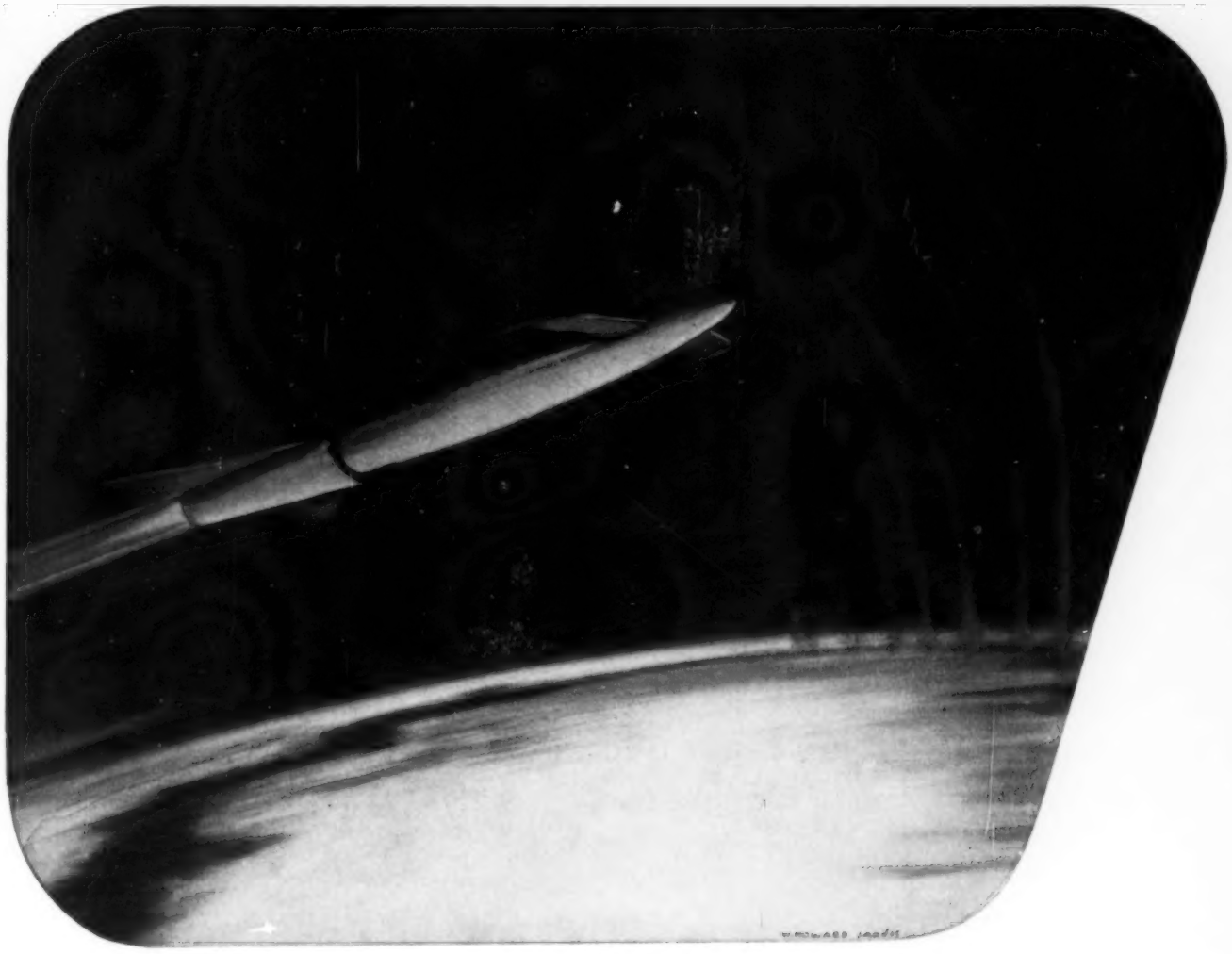
At 100ft the radio altimeter automatically disconnects glide-path guidance and for the next 5 sec or so the autopilot maintains the attitude which has been averaged for that approach. At 50ft the aircraft is over the runway and the radio altimeter supplies rate signals to control an asymptotic flare-out, while power is automatically progressively reduced to flight idle. At 20ft leader cable is discarded and the autopilot kicks off the difference between runway heading manually set on the beam compass and course held to counteract drift, at the same time holding the wings precisely level. Flare-out completed, the aircraft touches down at idling power and automatics are switched off. The pilot then follows visual leader-cable and compass information presented on the Flight System instruments and brakes the aircraft to a standstill. Actual touch-down velocity can be adjusted by re-programming either the throttling-back sequence or the flare-out. The main considerations are that the aircraft should make a positive arrival near the desired point without either landing too hard or floating too far.

The system can be disengaged at any time by releasing the autopilot and progress to each stage is shown by illumination of successive segments of a green-lit indicator dial. This is the only extra dial on the panel.

B.L.E.U. found that some completely independent means of checking automatic performance might be required, and work is progressing on Televiewer, in which a series of radio beacons along the runway transmit a TV picture equivalent to direct sight of runway lighting on to a screen in front of the pilot. To assess parameters for this a closed-circuit TV camera was mounted in the nose of a Devon and then in a Meteor "7/8/9." Night landings showed the required field of view and definition for an approach at 135 kt as ±13 deg in azimuth and ±10 deg in elevation with a definition of 10 min of arc. The lower limit was 50 min of arc. A 1:1 magnification ratio was used. Televiewer might form a pilot-operated automatic landing system in its own right.

A Canberra T.4 of B.L.E.U. completing an automatic landing. The tiny "pimple" on the nose is the leader-cable aerial.





On the Polar route to Australia

When, in the not-too-distant future, aircraft will be flying at stratospheric heights, they will be routed to the Antipodes 200,000 ft. above and across the white-out of the Greenland ice-cap.

The dramatic scene shown above is as accurate a pre-supposition of visual conditions on such a flight as present knowledge permits. Beams of very high-energy-charged particles from the sun enter the earth at the geomagnetic pole, causing disturbance to ionisation layers and temporarily destroying magnetic equilibrium.

The aircraft shown also represents a reasoned forecast of a type likely to be required for stratospheric flight. Esso are already evolving new fuels and lubricants to meet the conditions posed by such flight.

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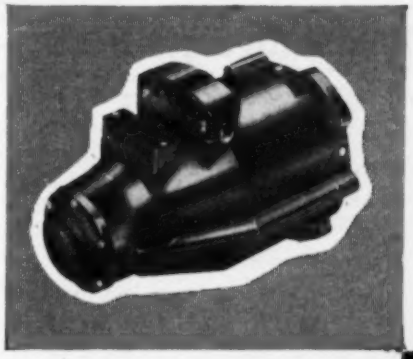

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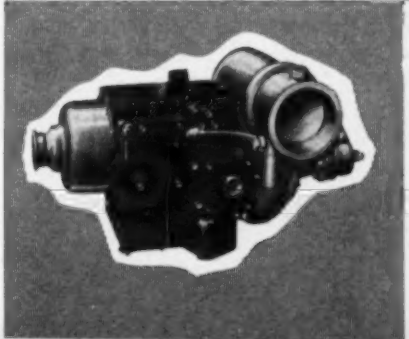

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AN ACCOUNT OF B.O.A.C.'s INTRODUCTION OF THE COMET 4: CREW-TRAINING AND FLIGHT PROCEDURES

ILLUSTRATED WITH "FLIGHT" PHOTOGRAPHS

BACKGROUND TO COMETS

THOUGH the early Comets were so suddenly eliminated from B.O.A.C.'s operations the Corporation's jet *savoire faire* survived. In the course of nearly two years—from May 1952 to April 1954—B.O.A.C. had flown nearly 30,000 Comet hours. As the intervening years have gone by, people have tended to look back on B.O.A.C.'s Comet 1 experience as a sort of brief experiment that ended in failure. But failure of the aircraft could not alter the historical fact of two years' highly successful pioneering in a new and revolutionary mode of air transport—two years which left a deep imprint of experience in the minds of all who flew and operated the Comet. Day and night throughout these two years the new operating techniques which the new form of propulsion demanded were developed, improved and refined; and though the corporate experience which resulted had to be put aside when the unit was disbanded, the experience of the men concerned—though dormant for three long years—ensured the continuity which permitted the B.O.A.C. Comet Flight to be re-established, in March 1957, smoothly and straightforwardly.

Continuity was also preserved by the appointment of a Comet 1 pilot to preserve the technical and operational link between the manufacturers and the Corporation. This was Capt. A. P. W. Cane, who had been flight superintendent of the Comet 1 fleet. Though keeping his hand in down the routes like the rest of the ex-Comet crews (he went on to Argonauts, while most others were transferred to Constellations), he was the Corporation's Comet-liaison man. His influence can be seen, for example, in the flight-deck layout, which is probably the best in any airliner to date. A practical flying man's influence is obvious here. Pilots' instrumentation, cockpit lighting, navigation equipment, engineer's station—these were typical of the technical problems which Capt. Cane advised upon from the earliest stages of the design.

When the contract for 19 Comet 4s was signed with de Havilland in February 1955, it was decided to take delivery—about a year before the Comet 4—of two specially modified and adapted Comet 2s. Known as 2Es, each had the extensive pressure-cabin modifications applied to R.A.F. Transport Command's ten aircraft, but were in addition revised to take two Comet 4-type Rolls-Royce Avon 524 (RA.29) engines in place of the outboard Avon 117s. The idea behind the two Comet 2Es was twofold: to amass flying hours on the Avon 524—which, though derived from the military Avon, was virtually a new design of commercial turbojet—and to rebuild B.O.A.C.'s Comet organization. These two essential objectives could obviously be neatly combined; and, though both aircraft were to be operated by B.O.A.C., one was owned by the Ministry of Supply.

The Comet Unit (now known as Comet Flight) was reformed in March 1957. Its original manager was Capt. Cane, with Capt. T. B. Stoney as his deputy. In October 1957 the unit was raised to Flight status when Capts. Cane and Field were appointed to special duties under the Corporation's technical manager (to do 707 and VC.10 as well as Comet liaison). Capt. Stoney was then appointed Comet Flight manager.

The first 2E was ready in August 1957, the second in September 1957. The plan was to operate eleven flights a week to Beirut, and the programme was launched on September 16, 1957. The Lebanese airport was chosen because flying to Beirut and back in the day gave just the necessary eleven hours per flight required to meet the target of 3,500 aircraft hours (i.e., 7,000 Avon 524 hours) by the end of May 1958. The aim was to clear the engines for a 500-hr overhaul life. In the event they were cleared for 1,000 hr.

The Comet 2E Unit was formed with 19 pilots. This was a sufficient nucleus for the 2E programme, and all the pilots were ex-Comet 1—a requirement for entry into the 2E Unit. However, the more recent Comet 4 personnel requirements have never been that everyone must be ex-Comet 1: obviously, B.O.A.C. could not crew 19 Comet 4s with the personnel from ten Comet 1s, even assuming that they were all available. In any case, since the demise of the early type there had been a change in the pilots' salary system—i.e., there were now varying salary-scales for different aircraft types. As a result pilots could bid, according to seniority, for transfer to new equipment. Such a bidding system, based on seniority, was the method by which names were chosen for the Comet 4 Flight; its obvious fairness avoids any awkwardness and suggestions of favouritism.

According to present plans B.O.A.C. will train rather more than 100 crews for the 19 Comet 4s—in accordance with the rough-and-ready rule of about five crews per aircraft. The Comet Flight has settled for a four-man flight-crew of two pilots, a navigating officer, and a flight engineer. Notwithstanding the present controversy, it looks as though B.O.A.C. have no intention of dispensing with full-time flight engineers on their jet airliners. Indeed, the flight engineer's station in the Corporation's Comet 4s is probably one of the most comprehensive of its kind.

Generally speaking, there are three types of pilot to be converted to the Comet 4: (1) those—19 in all—who were ex-Comet 1 and who are right up to date on the 2E; (2) the ex-Comet 1 pilots who have not been on the 2E; and (3) pilots who have had no jet experience. Initially, of course, the training programme has concentrated on the conversion of the 2E pilots; and here it is appropriate to retrace the programme which, on Saturday, October 4, 1958, culminated in the inauguration of passenger services across the Atlantic.

It was last January that B.O.A.C. first began to look seriously at the possibility of operating Comet 4s across the North Atlantic. They did not know at that time when Pan American would introduce jets on this route, but it seemed more than likely that PanAm might first put their early J57-powered Boeing 707-120s on the Atlantic rather than on to their Caribbean and South American routes. B.O.A.C. had to be prepared for this challenge, not simply for reasons of prestige, but because any airline exclusively offering jets across the Atlantic in the thin-traffic winter months—or in any season—is obviously going to get most of the business. So the Corporation had another look at the Comet 3 Atlantic "paper-jet" studies done four years before, applying the improved capabilities of the 4. Could such an operation be commercially and economically feasible? It looked like it. Between

Background to Comets . . .

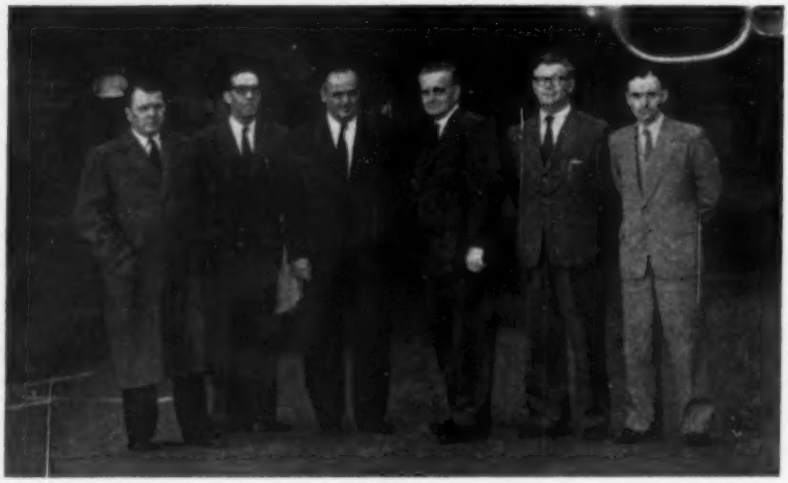
MEN IN CHARGE

COMET FLYING STAFF

(Left to right) Capt. T. B. Stoney, Flight manager; Capt. R. E. Millichap, deputy flight manager; Capt. J. N. Weir, chief of flight operations; Capt. B. G. Wallace, officer i/c training; Capt. A. P. W. Cane, special duties (technical manager).

COMET ENGINEERING STAFF

(Left to right, below) Mr. F. W. Jokiel, senior technical officer; Mr. F. E. Hart, base engineer; Mr. C. Abell, chief engineer; Mr. G. Halliday, superintendent of projects; Mr. R. J. McNaughton, maintenance survey engineer; Mr. T. Campbell, base foreman.



London and New York it was reckoned that the 4 might be able to lift 10,000-lb payloads in the winter and 12,000-lb payloads in the summer, with one stop on a high percentage of occasions westbound, and non-stop on a high percentage of occasions eastbound. In recent weeks, however, it has become clear that the 4 is, to quote B.O.A.C., "better than the book"; and there are hopes that considerably better payloads can in fact be carried.

Meanwhile, until last April plans were that inaugural services would start with daily flights to Australia. Target date was set for February 1959, assuming that four or five aircraft would be delivered by de Havilland by the end of 1958. But some time during April it appeared certain that PanAm were in fact going to put their 707s on to the Atlantic, and furthermore that they were going to do so in the autumn of 1958. It was decided to modify the Comet 2E programme—which by then was nearing completion—so that it could provide transatlantic jet experience. Instead of flying to Beirut and back, why not to Keflavik, Gander, the Maritimes, and the New York area? Because all but two of the 2E pilots were ex-Constellation—the Eastern-route aircraft to which the majority of ex-Comet 1 pilots had been transferred in 1954—the Flight's transatlantic route-experience was limited.

So towards the end of April 1958, Capt. Stoney got the go-ahead to switch 2E flying westwards across the Atlantic. There was only a limited number of 2E hours left to do, so the Ministry-owned 2E G-AMXD was withdrawn, and the revised programme concentrated on B.O.A.C.'s own 2E G-AMXK.

It was reckoned that eleven captains would be needed for initial Comet 4 services to New York. These eleven were dubbed the "Atlantic spearhead"; they were the first to be trained and they were given priority on all flights. The 2E programme was arranged in three phases, as follows:—

Phase 1: Eleven daily return flights to Gander, routed via Keflavik westbound. Each of the eleven "spearhead" pilots took part in four of these flights. Crewing was mixed so that everyone got experience of let-downs at Keflavik and Gander. After that exercise, which lasted for about 12 days, the aircraft went into the hangar for four days for the installation of Dectra. When this was completed the programme entered Phase 2, the idea of which was familiarization with the Maritime alternate airports, with the aircraft based on Gander.

Phase 2: Eight three-day trips, the first day of each consisting of a flight to Gander; the second being devoted to sorties from Gander to the Maritime airports of Goose and Stephensville, Sydney and Moncton, and return to Gander; and the return flight to London being made on the third. Then, having thoroughly cleared themselves at each of these Maritime airports, the crews were ready to branch further afield.

Phase 3: The plan here was to get to know the airports in the New York area. Eight further trips were made, as above to Gander on the first day, the second day being spent practising approach and let-down procedures at New York, Baltimore, Montreal and Boston.

No actual landings were made at New York—just the odd

touch-and-go, which was sufficient for the purposes of the exercise. All the pilots concerned were most impressed with the helpfulness of the American A.T.C. people. At first, because of the growing resistance to jet noise, there were certain reservations about procedures. For example, no approaches below 1,000ft were permitted. But after the New York authorities had been given data on Comet noise tests at Hatfield, these restrictions were relaxed, and the 2E was accepted as part of the normal traffic pattern. Not only did the 2E crews learn a great deal, but the American airport authorities in turn learned a lot about jet procedures and requirements in general. In particular, Baltimore were most friendly and co-operative: as one senior pilot said, "It has always struck me as appropriate that the name of that airport is Friendship." Crews always made a point of thanking everybody at all airports for their help before departing, and generally back came remarks like: "A great experience working with you." On one trip officials of the American C.A.A. and the Airways Modernization Board were given a ride to inspect the Decca/Dectra system; they saw how the 2E crews were able to employ the Flight Log not only for the Atlantic crossing but also in the Maritimes and New York areas, using the existing Decca chains.

The Comet Flight had trained eleven captains and six co-pilots by the time Comet 4 services began. For the record, and because B.O.A.C. have probably been too modest about the jet route-flying experience of their Comet 4 crews, it is appropriate to sum up this experience. When Comet 4 services began the Comet Flight had eleven captains all of whom had between 500 and 1,000 Comet 1 operational-service hours. Each had around 700 Comet 2E hours under route conditions, all of those hours having been accomplished during the previous 12 months. And each pilot had flown a minimum of 120 Comet 2E hours on the Atlantic route, and was familiar with all the alternates, A.T.C. procedures (including the language, which on the other side of the Atlantic is not always the same). Finally, each pilot had done routine Comet 4 conversion-flying, averaging six hours, at Hatfield and at London and Bedford. Conversion of 2E pilots to the 4 was, incidentally, perfectly simple; the two types have at least some of the same engine-type and handling qualities; the main dissimilarity —which in this case makes little difference from the pilot's point of view—is the greater length of the 4's fuselage. Transition was merely the mechanical business of take-off and landing.

It is true to say that when the 2E programme was completed last July, the Comet Flight felt in a very strong position indeed. If someone had said at that time, "Go ahead and operate," and had Comet 4s been available, services could have been started immediately. B.O.A.C. had in fact based their plans for an inaugural transatlantic service on a December 1 start; but, as is now well known, de Havilland produced the goods—delivering two aircraft on the contract date instead of one. This meant that B.O.A.C. were at once in business, and, as things turned out, they were able and ready to start services on October 4, nearly two months ahead of the original target date.

The training programme goes on and, indeed, will not be completed until December 1959. Ex-Comet 1 pilots with no 2E experience will have a ten-hour Comet 4 conversion course and check-flight and a minimum of three flights over the Atlantic route, including local flying and visits to all the alternates. Pilots with no previous jet experience will have a 12-hour conversion course, a check-flight and two or three route flights, according to the service.

The Flight has been hampered by the lack of a Comet 4 flight simulator, which is expected next April; but they have improvised very well with a converted Stratocruiser simulator. This now incorporates the Comet 4's Smiths flight system, which because of its newness could have been a bottleneck in the flying training programme. Most pilots will agree that there is nothing more disconcerting than sitting in a new type of aircraft in front of unfamiliar instruments. The Stratocruiser simulator was so controlled by the instructors that it could perform like the Comet in speed, rate of climb and—the most important operational feature of the jet—rate of descent. In addition, all the New York procedures were incorporated. Everyone spent between six and 12 hours on this simulator. There was also an arrangement with B.E.A. whereby Comet crews spent time on one of their Link trainers fitted with the Smiths flight system.

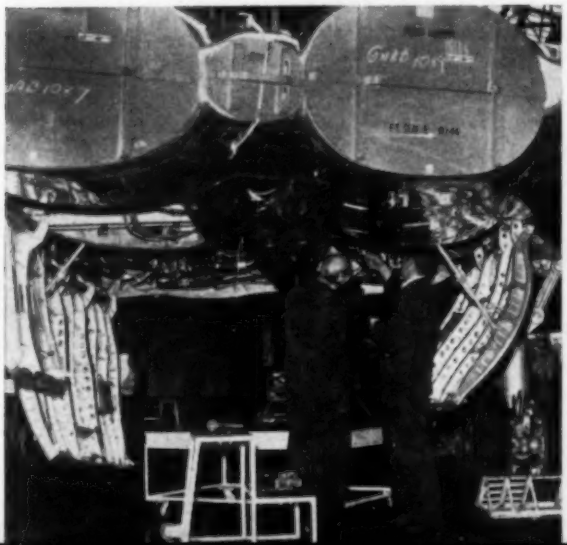
The Comet 4 flight-planning technique remains flexible, and will be improved as experience is gained. To start with, all flight-plans will be on the basis of a cruise-climb, as opposed to the stepped-climb, technique. On the 2E exercises pilots always asked A.T.C. for cruise-climb clearances, for as yet there is no commercial traffic at Comet cruising altitudes; but such clearances were by no means always granted. Often, because of military traffic, the pilots had to do 2,000ft or 4,000ft stepped-climb cruises —and sometimes even constant-height cruises—with considerable penalties in fuel as a result. For example, a 2,000ft stepped-cruise between London and Gander could cost 1,000 lb of fuel, which means five fewer passengers between London and New York. This is the crux of the jet's problem, and the reason why clearances to cruise-climb are always sought. The neatest answer is, of course, workable lateral-separation instead of vertical separation. Dectra, as fitted in one of the 2Es, showed pretty convincingly how this can be achieved; and B.O.A.C. can only hope that, in time, all airlines will adopt the system; obviously, lateral separation can work only if all carriers install the necessary equipment.

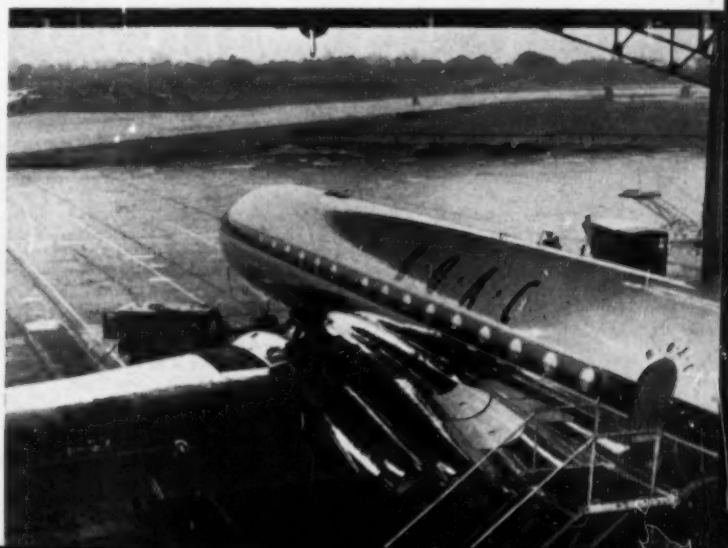
An entirely new flight-planning system has been devised for the Comet 4. Based on a cruise-climb, it provides for a cruise-climb to overhead destination, a continued cruise-climb and a descent to 1,000ft over the alternate. At this point sufficient fuel is reserved for holding at 20,000ft for 1¼ hr to 1¾ hr, depending on the sector. For example, on the sector to Keflavik the alternate is Prestwick; the flight plan is to arrive overhead Keflavik with fuel to permit a return to 1,000ft over Prestwick, where fuel for 1½ hr holding at 20,000ft will still be available.

In practice, assuming that the destination and the alternate are open, there need be no worries about using some of the reserve—if, for example, a stepped-climb cruise has to be made or if headwinds are stronger than forecast. If in any particular circumstances the captain feels that the reserve is being run down too far he can decide to land *en route*. This, of course, he can do in the Maritimes between Keflavik and New York, though for obvious reasons not between London and Gander. If the captain flying this critical sector is not happy with the weather at Gander and all its alternates he can divert *en route* to Keflavik, or return to Shannon. In the last resort, and assuming the crossing has been made out of H.F. contact with Gander, he can get to within V.H.F. range of Gander and *still* return to Shannon with 15 min fuel for holding.

Westbound, it is likely that there will be one stop on around 85 per cent of occasions, and two stops on the remainder, though

(Left) Wide underwing access-doors allow much Comet 4 maintenance to be performed at shoulder height. Here two B.O.A.C. engineers, working in the forward outer access door of the four under each pair of Rolls-Royce Avon RA.29s, are attending to services on the inter-engine firewall. (Right) Taken in B.O.A.C.'s No. 5 hangar at London Airport last week, this photograph gives an indication of what is now the daily round of the Corporation's maintenance. Overwing maintenance is limited to a single engine services access panel above each powerplant. White wing-root panels enclosing passenger dinghies are a feature of B.O.A.C.'s Comet 4s.





Study session in the Comet 4 cockpit. The First Officer is indicating the flying-control hydraulic system change-over levers.

Background to Comets . . .

in the event this may well be bettered. Eastbound, the procedure will be to flight-plan from New York to Shannon, with London as the alternate—a slightly different concept than flight-planning non-stop to London. Whether or not this plan is adopted will depend on winds and payload. Probably the only factor which will prevent the direct New York - London flight will be the weather conditions at London. On training flights full tanks (70,600 lb) will be carried, but on commercial services the operation will be gradually refined until the optimum figure for the season and the sector concerned can be determined. Flight-planning has been deliberately biased towards fuel, for the good commercial reason that, as experience is gained, it is always better to be able to say to the commercial department that you can carry more, rather than less, payload.

Plans for the expansion of Comet operations are now fairly firm. As is well known, B.O.A.C. intend to work the Comet Flight hard—up to an annual utilization per aircraft of nearly 4,000 hr within two years. About the middle of next month, probably, services to New York will be stepped up to once-daily frequency. Next May a four-times-weekly service to Tokyo will begin. By September, Hong Kong and Singapore will be served and by December five services a week to Sydney may be started. Early in 1960 services—possibly daily—to South Africa are envisaged, followed by others across the South Atlantic to South America.

In their Comet Flight B.O.A.C. appear to have built up a team of exceptional calibre and spirit. Each member is a devotee of the Comet, an aeroplane that always seems to extract superlatives from the people who work with it. In the coming years a great deal is expected of the aircraft and the team behind it: evidence for this is the planned utilization-rate—higher than any previous B.O.A.C. aircraft, and indeed as high as is achieved by the equipment of any long-haul operation—and in the world-wide route-network which B.O.A.C.'s Comets will open.

KOLIBRIE COMPLICATIONS

TWO members of the Board of the Nederlandse Helicopter Industrie, G. F. Verhage and J. Meyer Drees, recently offered their resignations. The reason (writes a Dutch correspondent) seems to be that lack of orders for the H-3 Kolibrie helicopter, which they designed, has involved the company in financial difficulties. Up to now 14 Kolibries have been built but only four sold (to the Israeli Air Force), and the Royal Netherlands Air Force have decided not to buy the Kolibrie as it is too small for their purposes. Resignation of the two directors, says our correspondent, "could mean the end of this very promising aircraft, as well as of the company who build it." There is, however, some hope (he adds) that things may be settled; and there is a chance of additional orders for spraying operations next spring.

AGARD MEETINGS

CONVENING in Copenhagen on October 23, the 13th AGARD aeromedical panel meeting is to hold a two-day symposium on *Escape and Survival*. About 15 papers will be presented.

At the eighth general assembly of AGARD (Advisory Group for Aeronautical Research and Development), which is also being held in Copenhagen (October 28-29), there is to be a round-table discussion on *The Impact of Space Technology on NATO Research and Development*.

Among papers to be presented will be *Biomedical Aspects of Space Flight*, by Brig-Gen. Don Flickinger, Director of Life Sciences, Air Research and Development Command, U.S.A.F.; and *Structure and Material Problems*, by Richard V. Rhode, Assistant Director for Research, NACA, and John C. Houbolt, Langley Aeronautical Laboratory, Langley A.F.B., Va.

I.G.Y. DATA CENTRE

A THIRD World Data Centre for Rockets and Satellites is now operating at the D.S.I.R. radio research station at Ditton Park, Slough, Bucks. Previously there were only two such centres, in Moscow and Washington, and it was agreed at the recent Moscow meeting of the I.G.Y. special committee to accept the British offer of another one.

As many of the I.G.Y. experiments are concerned with investigations of the ionosphere, and studying the travel of radio waves from satellite transmitters is one way of gaining information about it, Ditton Park forms an appropriate location for a data centre. Its workers and those at its Singapore sub-station are engaged in such studies, together with scientists at the Post Office Radio Station, Banbury, the Cavendish Laboratory at Cambridge University, the Great Baddon laboratories of Marconi's Wireless Telegraph Co., the R.A.E. Farnborough, the R.R.E. Malvern and the Admiralty Signals Research Establishment, Portsdown.

C.A.I-I.A.S. MEETING

AT the 1958 joint meeting of the Canadian Aeronautical Institute and the Institute of the Aeronautical Sciences, held in Ottawa on October 7-8, technical sessions were devoted to aero-medicine, aeroelasticity, propulsion, environmental testing, aircraft actuating systems, materials and test flying. Principal speaker at the banquet on October 7 was Mr. Elwood R. Quesada, chairman of the U.S. Airways Modernization Board. The following papers were presented:—

Aeromedicine: *The Design of Training Equipment*, C. P. Seitz, Grumman Aircraft Engineering Corp; *Functional Mockups for Aircrew*, M. G. Whillans, Biosciences Research, Defence Research Board; *Recent Studies of Human Requirements in Hypersonic Escape*, A. W. Hetherington, Directorate of Life Sciences, A.R.D.C.

Aeroelasticity: *The Use of Models in Aeroelastic Analysis*, J. McKillop, Engineering Div., Avro Aircraft, Ltd.; *The Flutter of Low Aspect Ratio Wings*, W. P. Targoff and R. P. White, Jr., Cornell Aeronautical Laboratory; *The Aeroelastics of Tall Stacks*, R. A. Boorne, Mount Allison University.

Propulsion: *Design and Applications of Mach 4 Turbine Engines*, M. A. Zipkin and R. E. Neitzel, Flight Propulsion Lab. Dept., General Electric Co.; *Rocket Propulsion in Canada*, R. F. Wilkinson, Explosives Wing, C.A.R.D.E.; *Powerplant Design Considerations for VTOL Jet Transports*, Martin J. Saari, Lewis Flight Propulsion Laboratory, N.A.C.A.

Environmental Testing: *Environmental Simulation, Its Meaning and Value in System Testing*, C. A. Mills, Electronics Div., Canadian Westinghouse Co., Ltd.; *The Ordnance Corps Envanal System*, H. M. Bunch, Environmental Research Sect., Southwest Research Institute; *Operational Value of Test Specifications*, E. B. Moss, Canadian Applied Research, Ltd.

Aircraft Actuating Systems: *Pneumatic Actuating System for 1,000° F. Operations*, John A. Osterman, Advanced Systems Research, Georgia Division, Lockheed Aircraft Corp; *Design of Hydraulic Systems for High Speed Aircraft*, D. Royston, Engineering Div., Avro Aircraft, Ltd.; *The Rôle of Electrical Actuating Systems in Supplementing Sea Master Flight Controls*, H. C. Zachmann, Electronics and Electrical Dept., The Martin Co.

Materials: *Close-tolerance and Other Special Forgings*, W. Morgan, Research and Metallurgy, Canadian Steel Improvement, Ltd.; *Thermal Insulation Ceramic Coatings*, A. V. Levy, Material and Process Section, Marquardt Aircraft Co.; *Ultra High Strength Steels*, W. B. F. Mackay, Atlas Steels, Ltd.

Test Flying: *Broad Outline of Aircraft Feel; Pilot's Appreciation*, W. J. Potocki, Avro Aircraft, Ltd.; *Piloting Research Aircraft*, J. Walker, High Speed Flight Station, N.A.C.A.

On the day following the joint meeting, the first meeting of the Astronautics Section of the C.A.I. was also held in Ottawa. Papers read and discussed were: *The Clock Paradox*, W. F. Campbell, National Research Council; *Propulsion Systems for Space Travel*, Dr. H. S. Ribner, Institute of Aerophysics, University of Toronto; and *Guidance and Control*, R. D. Richmond and D. Bogdanoff, Canadair, Ltd.

FOR THE ARGOSY

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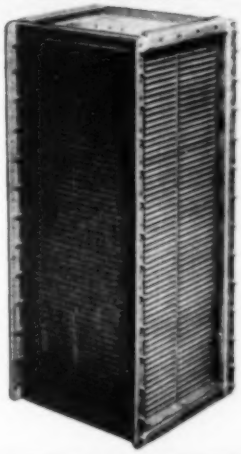

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Argosy

A.W.A.'s NEW TRANSPORT

By THE TECHNICAL EDITOR

"For I dipt into the future, far as human eye could see,
Saw the Vision of the world, and all the wonder that would be;
Saw the heavens fill with commerce, argosies of magic sails,
Pilots of the purple twilight, dropping down with costly bales."
TENNYSON

ACCORDING to the Shorter Oxford Dictionary, an argosy is "a merchant vessel of the largest size and burden." This definition is not, perhaps, wholly appropriate to the second of the commercial aeroplanes from Sir W. G. Armstrong Whitworth Aircraft to be so named (the first was, of course, a famed airliner of Imperial Airways of the 1927-1930 era), for the new AW.650 Argosy is by no means "of the largest size," nor is its "burden" as great as that of many types now coming into commercial service. It is for these very reasons that the Argosy promises to fill a most important gap in the range of available transport aircraft, offering an unprecedented combination of operational flexibility and efficiency in a size which, while large enough to make the cost per ton-mile competitive, is not too much for a wide range of commercial and military operators to handle.

From its inception the Argosy has been financed entirely by its manufacturer; and it is very much a co-operative Group project, since it is the only firmly established civil aeroplane among the entire Hawker Siddeley Aviation Division. It promises to evolve into a range of related types, some designed for a variety of passenger, freight or mixed transport, some intended for short-haul car or passenger ferrying, and yet others being tailored to the needs of the world's air forces. First, however, it is appropriate to relate how the programme began.

Three years ago the Air Ministry formulated an operational requirement for a new transport landplane for passengers or heavy freight. The specification called for a machine of a size roughly midway between that of the Valetta and the Beverley, and with a performance surpassing that of either of the earlier aircraft. It was specifically suggested to tendering companies that particular consideration would be given to aircraft designed to appeal also to commercial operators.

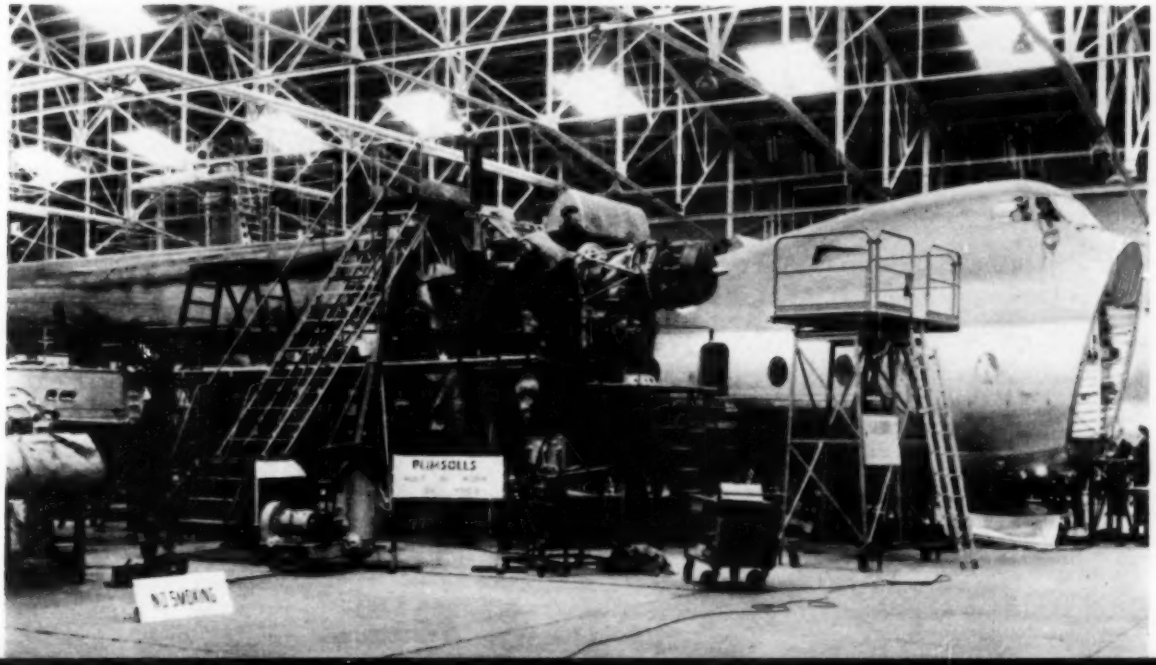
Late in 1955, Armstrong Whitworth set a design team to work on a machine to meet this need, and concurrently discussions were held with numerous air forces and civil operators throughout the world. Europe was covered by the A.W.A. sales staff at Baginton and London, while prospective customers further afield were interviewed by the regional executives of the Hawker Siddeley Group. These discussions soon confirmed what the company had been hoping: that the R.A.F. aeroplane was of a size and character likely to interest a very large number of operators throughout the world. At the same time it came to be appreciated that the aircraft would have to have the maximum possible operational flexibility, and to achieve the fullest success would need to be capable of rapid turn-round with any kind of load, ranging from passengers to heavy freight.

A submission to the Ministry of Supply was made with a high-wing aircraft bearing the works number AW.66. The brochure described a machine with a gross weight of 65,000 lb and two 3,000 h.p. turboprop engines. The fuselage took the form of a truncated nacelle, with a beaver-tail provided with a loading ramp and doors to permit truck-bed loading and heavy dropping (to meet an obvious military requirement). From the sides of this nacelle relatively narrow appendages extended to the rear, terminating in a pair of vertical tail-surfaces atop which was mounted the horizontal tail—forming what is colloquially known as a pi-tail, from its resemblance to the Greek letter π. Basic design work was put in hand at once, and tunnel models proved the satisfactory aerodynamic behaviour of this unconventional configuration.

Soon, however, it became evident that the pi-tail and closely spaced booms allowed little latitude in the design of the rear end of the fuselage. Hardly any commercial operators had a requirement for heavy dropping, their prime needs being the maximum rapidity and flexibility of loading and unloading on the ground. When operating in the freight rôle it is a great advantage to have a full-section door at both ends of the hold, so that sector traffic can be loaded and unloaded rapidly from either end. The resulting large end-doors posed a major design-problem.

Clam-shells and upward-hinging arrangements were investigated in some detail, but the need to provide for manual opening and closing, and the fact that each door could form a valuable addition to the payload accommodation—housing baggage racks

Taken last week at Bitteswell, this photograph shows the first production Argosy, G-AOZZ, with its inboard Rolls-Royce Dart 526s installed.



ARGOSY . . .

and toilets, for example—soon made it apparent that the optimum arrangement for a commercial machine was to have a simple single door at each end, hinged about a vertical axis and opening sideways. This precluded the use of the pi-tail, and accordingly a new empennage was designed carried by more conventional booms attached to the wings. Design teams held discussions with Fairchild and Nord Aviation, both experienced manufacturers of twin-boom freighters, and returned assured that, if properly designed, the twin-boom configuration could be made completely satisfactory in all respects.

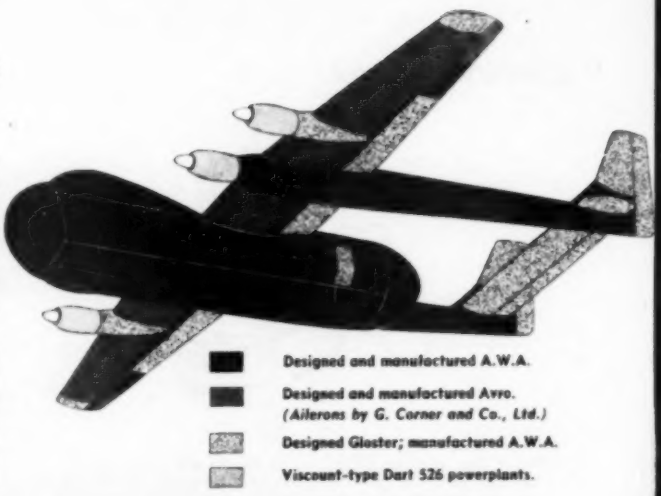
This at once opened the way to further variations on the basic theme. The wing, booms, tail, powerplants and undercarriage were visualized at a basic lifting and propulsion system, to which could be added different types of payload accommodation to suit the conflicting needs of the multitude of interested operators. Even at this early stage Armstrong Whitworth conceived the idea of designing a variety of fuselage configurations which could be offered as optional alternatives while adhering to the same basic aircraft design.

Investigations into the optimum wing required led to the fortuitous discovery that there existed in the Hawker Siddeley Group a fully developed wing with characteristics almost indistinguishable from those needed by the new transport; this wing, that of the Avro Shackleton, was found to form an excellent basis for development, and it was accepted as such by the Armstrong Whitworth designers. This decision at once saved substantial development expenditure and made possible a great reduction in the time and effort required to evolve both the wing and its associated tooling.

At the same time very extensive research was undertaken to determine the optimum type of fuselage. The need for truck-bed loading suggested a flat and level floor at a height of about four feet from the ground. This requirement precluded the use of under-floor stowage, and so dictated a relatively flat belly, the fuselage reaching its full width at floor level and thereafter continuing upwards with bulged sides to provide a completely unobstructed box-like interior. The floor was designed to a ruling loading of up to 200 lb/sq ft and the overall payload then determined the usable floor area. The need for straight-through loading and unloading with a full-section door at each end determined the location of the flight deck on a level entirely above that of the payload accommodation. The resulting configuration has a cross-section resembling that of a cottage loaf. The flight deck is faired at its rear end into the leading edge of the wing, the space beneath the fairing being ideally suited to the accommodation of numerous systems-components. The flat floor of the flight deck and equipment bay forms the forward roof of the cargo hold.

Notwithstanding the fact that most operators of such aircraft are interested primarily in relatively short-haul operations, it was decided from the outset to pressurize both the flight deck and the complete cargo hold. Gas-turbine propulsion and full pressurization and air-conditioning are virtually essential for the acceptance of an aeroplane offered for passenger transport, and at the same time pressurization is extremely valuable during the carriage of livestock and even such apparently inert cargoes as blood plasma and wool. Almost every prospective operator considered such provision to be well worth the additional weight and complication involved.

By 1956 it was becoming apparent that the money available for the purchase of new British military aircraft was to be progressively curtailed, and the Air Ministry requirement faded out without any decision having been taken. By this time, however, A.W.A. were so convinced of the "rightness" of their design, and of the fact that it could be commercially successful, that work was allowed to continue. This time, however, the project was designated AW.65, and it was regarded as primarily a civil aeroplane with obvious military applications, instead of the other way round.


Designed and manufactured A.W.A.
Designed and manufactured Avro. (Ailerons by G. Corner and Co., Ltd.)
Designed Gloster; manufactured A.W.A.
Viscount-type Dart 526 powerplants.

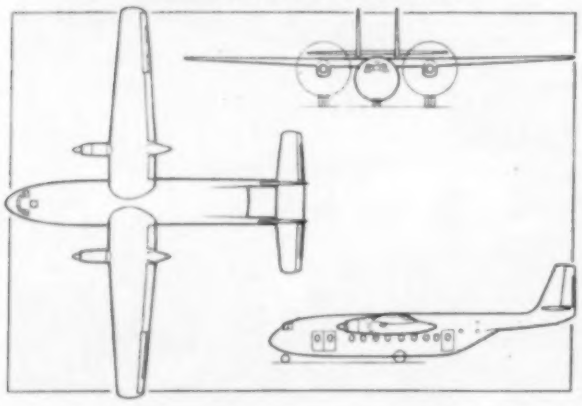
Who does what: an Argosy production analysis.

This changed outlook at once made it imperative to select fully tried and proven powerplants. The choice taken by the A.W.A. designers was to employ four Rolls-Royce Darts, and the wisdom of this decision is difficult to challenge. Owing to its ancestry the wing already made provision for outboard powerplants, and the increased power of four Dart RDa.7s (8,400 e.h.p. compared with the 6,000 of the original project) permitted a valuable increase in gross weight, first to 76,000 lb and finally to 82,000 lb. This made the aircraft even more attractive, and by the autumn of 1956 the design had settled down as a firm project, bearing the designation AW.650; initially given the name Freightliner or Freighter-Coach, it was formally and more happily named the Argosy in July of this year.

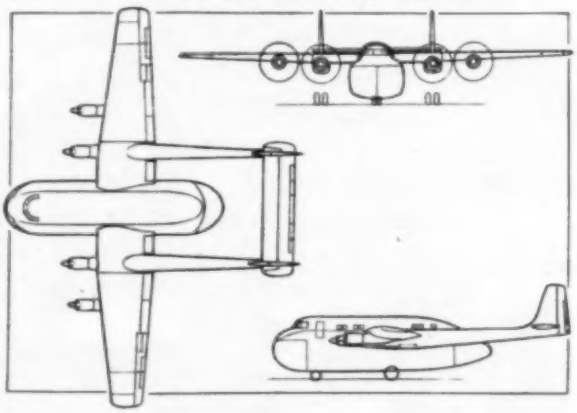
The Board of the Hawker Siddeley Group authorized A.W.A. to launch a complete programme on September 11, 1956. By this time it was realized that, if complete commercial success was not to prove elusive, the company must do much more than merely tender to an official specification; they would have to establish a programme for the new aeroplane fully equal to that of any other manufacturer in the world. In the two years that have since elapsed, every department of A.W.A. has been enormously strengthened, and particularly is this true of all forms of research and testing, sales, market research, customer liaison and "planning" in all its ramifications.

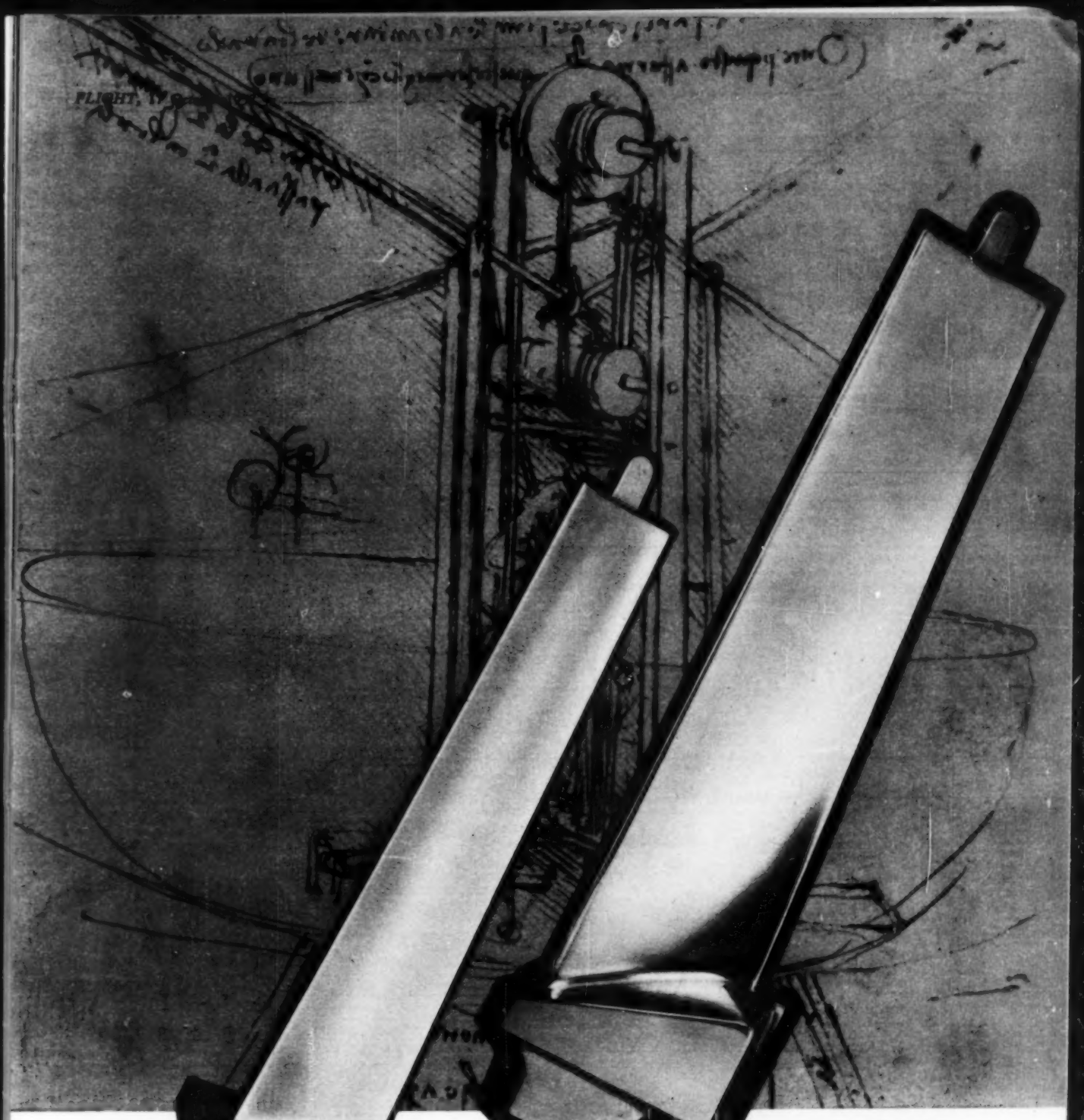
Ever mindful of the evils of what has been called "too many channels for too little water," the Group agreed to spread the load as widely as possible in order to achieve the tightest possible schedule. The parent company undertook the design and manufacture of the complete fuselage, the tail booms, the wing trailing-edge, the double-slotted flaps and the basic design of the empennage; Avro assumed responsibility for the extensive redesign and manufacture of the entire wing; Gloster handled the detail design of the side doors, flaps, outer nacelles and tail unit; and Air Service Training contributed numerous details, particularly with regard to ground equipment. From outside the Group, Rolls-Royce and Vickers-Armstrongs (Aircraft) contributed the complete power package forward of the firewall, this unit being virtually identical with that of the Viscount; Dowty were assigned the task of delivering the undercarriage, and other major sub-contractors brought in at this stage included Dunlop (wheels,

Early concept: the "pi-tail" AW.65 of 1955-56.



AW.670 Air Ferry short-haul cargo freighter.





Background illustration from
Leonardo da Vinci's Notebooks
(c. 1505) "Mechanism of a flying machine"

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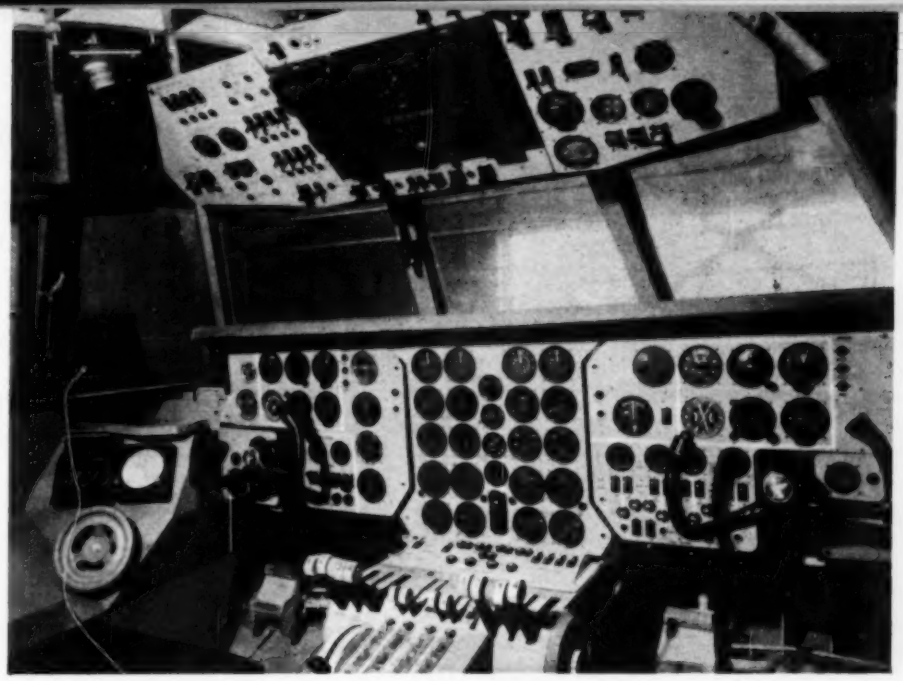
ARGOSY . . .



Armstrong Whitworth have built two complete flight-deck mock-ups. One features a "British" layout, and the other —shown here—is equipped for North American operations, with a third seat. A detailed drawing of a complete flight deck appears on pages 630-631.

tyres and brakes), Napier (Spraymat de-icing), Hobson (flap gearbox and actuator), Lockheed and Integral (hydraulics), Godfrey and Normalair (cabin air) and Rotax (electrics).

Selling new aeroplanes in the open market has become an exceedingly competitive business, and the Hawker Siddeley Group were determined to stretch their abilities to the utmost in order to give the 650 the maximum possible chance of success. Instead of cautiously constructing a single prototype, the Group agreed to sponsor the manufacture of a complete batch of ten aircraft in production jigs, in addition to two complete airframes for static and fatigue testing. At the same time, work progressed on a very broad front in the fields of detail design, systems and structural testing and all the thousand and one facets of a programme of such magnitude.

Meanwhile, the basic concept of the 650 continued to be the subject of progressive improvement to meet the conflicting and changing needs of military and commercial operators (with whom A.W.A. had remained in the most intimate contact) throughout the world. A relatively simple modification, to some extent marking a reversion to the original AW.66 configuration, was the substitution of two Rolls-Royce Tyne turboprops for the four Darts. By 1961 the Tyne should be a commercially available engine of more than 5,000 h.p. with a lower weight, drag and specific consumption than any other engine of comparable power. The twin-Tyne project was given the number AW.651 and it is regarded as a promising proposal for the future, particularly for operators of relatively long segments.

In order to provide adequate clearance for the larger Tyne propeller the inboard engines (and, therefore, the tail booms) were moved further outboard than they had been in the original Shackleton. This at once opened the way to a major implementation of the concept of fuselage-flexibility made possible by the twin-boom layout. A completely new fuselage was designed, with an interior width of no less than 180in and accommodation for payload on two decks. This relatively enormous body was tailored to fit neatly on to the basic 650 wing, while still retaining sufficient clearance between the inboard propellers to prevent the problem arising. At the same time the pressurization system was deleted and the single cargo doors of the 650 were replaced by much lighter clam-shells. Thus was born the AW.670.

There are to be two major variants with this capacious, unpressurized fuselage. The AW.670 Air Ferry is to be a short-haul cargo freighter. Various types of loading system are being investigated, and typical lower-deck loads may be two lines each of five pre-packed cargons with an aggregate weight of over 29,000 lb, or in the car-ferry rôle two rows of cars totalling six vehicles with a weight greater than 20,000 lb. In either case up to 30 passengers with baggage may be accommodated on the upper deck, within the limits of the available payload. The AW.671 Airbus is specifically intended for short-haul passenger operation, seating 30 on the upper deck and approximately 96 on the lower deck. On stages shorter than 200 miles the Airbus bids fair to have a direct operating cost per seat-mile lower than that of any other new aeroplane.

For military operators, the AW.660 is essentially similar to the 650, the major change being replacement of the rear cargo door by a beaver-tail arrangement providing for ramp loading and heavy dropping. This configuration comprises upper and lower doors, both power-operated, as illustrated in a photograph of a model on p. 624. A twin-Tyne version of the military machine is designated AW.661.

The ensuing text is devoted primarily to the existing AW.650 Argosy. The account concludes with an outline of the present development programme, basic data and estimated performance figures and a list supplied by A.W.A. of their chief Argosy suppliers and sub-contractors.

THE 650 IN DETAIL

As already noted, one of the basic decisions taken during the design of the Argosy was to employ a completely unobstructed cargo hold with full-section doors at either end. This placed the flight deck above the floor of the freight hold and the remaining geometry of the aircraft was largely determined by the length of the main undercarriage units and the height of the tips of the fins. Accordingly, the wing spars were sunk into the upper part of the fuselage and the cross-section of the latter chosen to give an interior hold height of 80in. The roof of the flight deck was swept down to the rear to meet the mould line of the basic fuselage at the leading-edge of the wing.

In general, the fuselage, like the remainder of the airframe, is built up from conventional light-alloy sheet and sections fabricated by riveting and Redux bonding. Where bonding is not employed, the sheet is to the close-tolerance D.T.D. 710 specification, D.T.D. 746 being employed for the Reduxed parts; bars and forgings are mainly in L.65 material. It is appropriate to comment at this point that Aero Research—now CIBA (A.R.L.), Ltd.—and Bristol Aircraft, Ltd., provided considerable assistance in establishing the Argosy bonding programme, but the Coventry company are now self-sufficient in this regard. Fail-safe principles have been employed throughout the structure by adopting relatively low stress-levels, eliminating stress concentrations and providing crack-stoppers, bonded doublers and finger-plates at all joints or cut-outs.

For manufacturing purposes, the open-ended monocoque fuselage is divided into logical portions comprising the floor and under-floor structure, side panels (incorporating window members), flight-deck floor and superstructure over the flight deck and equipment bay. These sections are then brought together and rapidly joined, a moving erection-jig in the form of a glass-fibre truss being employed inside the freight hold.

Nearly all the frames are vertical, and the ruling spacing is a pitch of 21in. Apart from the manufacturing joints, each frame is unbroken, running right through to meet the finger-plate rip-stoppers and skin, as shown in a detail sketch on the back (pages 630-632) of our fold-out illustration. Beneath the cargo floor the frames are generally channel sections. Above the floor they are mainly of I-section, having a plate web and angle booms; certain major frames, such as those in line with the wing spars, have spaced double webs, extruded booms and capping strips around the inner periphery. The stringers, being employed as intercostals, are attached to either side of the frame webs by riveted angle-pieces, continuity of the inner booms being provided by channel section "fish-plates" passing through holes drilled in the frame web. The finger-plates are riveted around the outer periphery of each frame, providing an alternative load-path and joining the outer ends of the stringers; at circumferential skin-

MEN BEHIND THE ARGOSY

Here and on the opposite page are portraits of some of the men holding key positions in the Argosy programme. On the extreme left is H. M. Woodhams, Armstrong Whitworth Aircraft managing director, and next to him is W. S. D. Lockwood, director and general manager; in the second row are, left to right, E. D. ("Dixie") Keen, chief designer; E. G. Franklin, chief test pilot; Dr. W. F. Hilton, chief aerodynamicist; D. Woodley, assistant chief designer (technical); R. Dean, assistant chief designer (projects); and A. J. Troughton, chief structural and mechanical engineer.

ARGOSY . . .

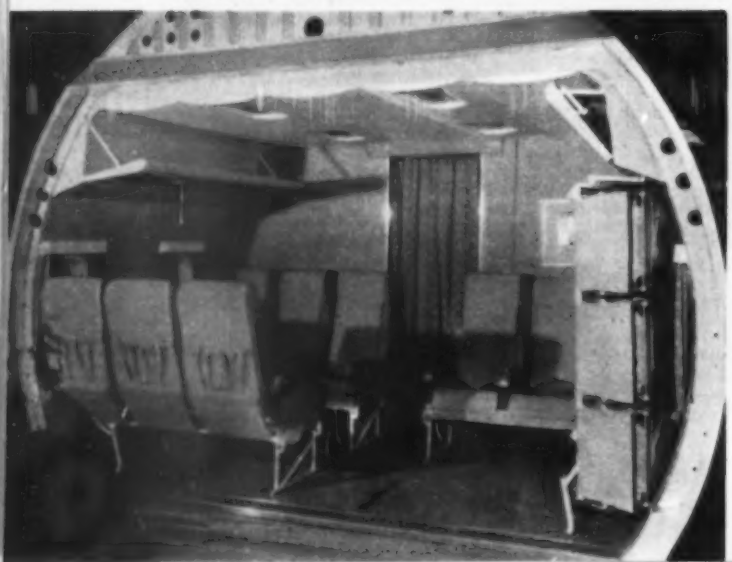
joints the finger-plates are made wide enough to form a joint strap for the skin also. Finally the skin itself is put on in modest sections, using snap-head riveting.

The main frames aligned with the wing spars are of U-form, each terminating at its port and starboard attachments to the wing. Each of these attachments takes the form of two pin-joints, which together have the effect of isolating the wing/body strains while serving as a fixed-ended beam to reduce stress in the frame itself. The upper pin-joints are placed at the neutral axis of the wing spars and the lower joints comprise vertical swinging links which bear the weight of the fuselage and its contents. Additional drag-links are provided in a substantially horizontal plane. Aft of the rear face of the front spar the upper decking of the fuselage is curved, this being the optimum form to resist the cabin pressure-differential. The rear spar is thus accommodated in a deep slot and the vertical pressure-bulkheads adjacent to the spars are stiffened by corrugations or top-hat sections. Beneath the spar slots a steel strap is riveted along each side of the fuselage.

Both the freight floor and flight-deck floor are entirely flat and level. The flight-deck floor is supported on transverse beams of I-section, which form ties holding the two sides of the pressurized hull together. Each beam terminates in a series of Reduxed laminations forming a pin-jointed anchorage to the adjacent frame. The simple floor-skin is flush-riveted directly to these beams. The main freight floor is the subject of a detail sketch on p. 631. Transverse plate webs or truss girders aligned with the frames carry cross-rails on which are laid six longitudinal rails formed from special light-alloy extrusions. These six rails are spaced 20in apart and have slots in their upper faces at a pitch of 2in to receive freight lashings or seat attachments. Between the rails are laid the floor panels, which are Reduxed sandwiches with a corrugated metal interior.

Each end of the fuselage is sealed by a sideways-hinging freight door. Each incorporates stiff bonded-sandwich frames and floor panels, and in the centre of the nose door is a pressure bulkhead, ahead of which may be mounted a search-radar scanner. Both doors are mounted on three hinges, the central hinge bearing the door's not inconsiderable weight. Opening and closing is effected either manually or (on the fourth and subsequent machines) hydraulically via a gearbox driving a lengthy lead-screw with an irreversible thread. As each door is closed, a small sprung lever (item 10 in the large drawing on p. 627-629) seats itself on a socket on the fuselage bulkhead and lifts the outer edge of the door sufficiently to counteract any slight sagging which, caused by structural deflection, would otherwise prevent the door from seating properly. When a door is home it is locked by a series of sequenced hydraulic latches energized by a hand pump. Each latch consists of a lug which is extended from the periphery of the door and, when this action is complete, is locked between a mating fork-fitting on the fuselage by a hydraulically inserted pin. A sketch of one of these latches appears on p. 632. The nose door has eighteen latches and the rear door fifteen; the factored static load due to full cabin pressure is about 80 tons on each door. Sealing is achieved conventionally by an inflatable rubber strip.

This fuselage section, here seen at the recent S.B.A.C. Show, is now part of Argosy No. 6. One of the triple seat units is shown folded.

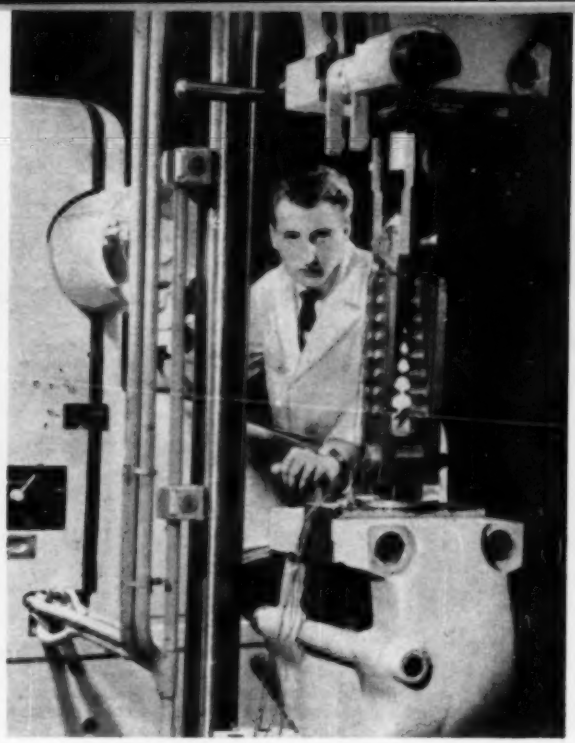


On the right are D. L. Raffle, chief performance engineer, and (for right) H. F. Butler, project design.

Notwithstanding its Shackleton ancestry, the wing of the Argosy can be regarded as a substantially new design. Compared with that of the maritime patrol machine, the Argosy wing has differently spaced engines, provision for mounting tail booms, a completely new thermally de-iced leading edge, large double-slotted flaps and square tips. There are also many aspects in which the detail design is changed; in fact, 90 per cent of the drawings for the Argosy wing are new.

Each mainplane is constructed in five sections, comprising centre-section, intermediate planes and outer panels. Each portion has two spars with mass booms. The main ribs between the fuel cells are truss girders, the remaining ribs being peripheral sheet pressings surrounding the inner skins of the tank bays. Wing bending moments are almost entirely absorbed by the spar webs, the relatively light skin being required to carry only torsional and local aerodynamic loads. The wing leading-edge, which is hinged throughout its length for access to electric, hydraulic and de-icing systems, has a corrugated interior wall.

There are six sections of double-slotted flap, each section being operated by a pair of endless chains driven by sprockets on a spanwise torque-tube on the rear face of the rear spar. This torque-shaft is driven from a centralized gearbox actuated by main and emergency Hobson hydraulic motors. Flap angle is varied with the extension by tie rods and a roller/track system, as shown in a small sketch on the main drawing on p. 628. The tracks are light-alloy forgings with steel liners in which the rollers



Argosy hardware, controlled by the men pictured below, is typified by these photographs. Above are seen sections of the fuselage—actually the underfloor structure at the rear, where tubular Warren trusses support the cargo floor—in their vertical jigs. On the right, and representative of an immense structural-test programme, is a tail-boom/wing joint being calibrated for structural-integrity flight testing. The machine is a 60-ton Losenhausen.

ride during the early part of the flap-operating cycle; towards the end of their travel the flap noses leave the open rear ends of the tracks and further extension pulls the flaps down to their maximum angle of 50 deg. Flap stiffness—increased by employing fluted skin—is sufficient for each section to be operated by one chain only, should the other chain fail.

Beneath the two main ribs behind each inboard engine extends a strong light-alloy tubular structure to which are attached a main undercarriage unit, inboard power package and tail boom. The forward part of this structure incorporates a mounting frame for the accessory gearbox and terminates at the stainless-steel firewall. The tail-boom anchorages occur approximately in line with the rear spar. From this member a plate bulkhead extends vertically downwards, forming the rear end of the heavy tubular structure previously referred to. On the rear face of this bulkhead are bolted a pair of diagonal brackets extending well down below the wing, carrying at their lower extremities the fork-fittings for the two bottom longerons of the tail boom. The two upper boom longerons are anchored to fork-fittings bolted to the two inboard engine ribs.

Each boom is structurally identical with its partner, construction being of semi-monocoque form, with channel or I-section frames, Z-section stringers and a skin of relatively heavy gauge (14 s.w.g.) to ensure that cracks will not propagate. At the forward end of each boom the frames are heavy, horseshoe-like structures open at their lower ends to admit the retracted main-undercarriage units. Main structural loads in this region are borne by the four longerons, which at the rear of the undercarriage bay fade into the optimum monocoque structure. In the latter the frames are simple hoops and, unlike those in the fuselage, do not extend through to the skin. At the rear of each boom is attached a non-structural, glass-fibre dorsal fin, extending to the rear fin-stubs and carrying mountings for the tailplane. Above the tailplane are attached further stubs on which the fins are anchored.

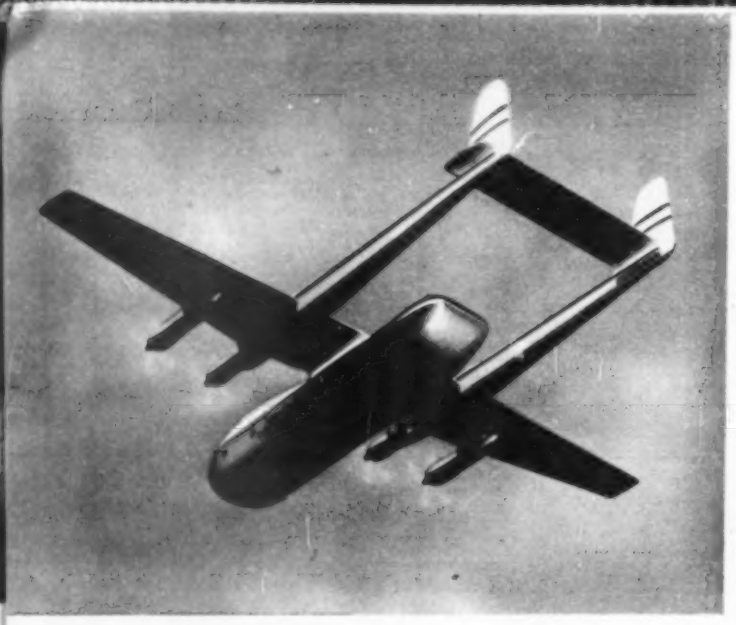
Built in one piece, the tailplane is a completely fail-safe structure. Its two spars each comprise a web formed from two sheets bonded together and four concentrated angle booms. The skin is stiffened by multiple bonded spanwise stringers; and the leading edge, which can be unscrewed, carries Spraymat de-icing. In order to permit independent deflection of each tail boom the tailplane is pin-jointed to the latter through four attachment-forks, each picking up lugs on double frames at the rear ends of the booms. Flexibility in the horizontal plane cannot be accommodated, as the structure forms a portal frame.

Fin construction is straightforward, each unit comprising a detachable leading-edge, with Spraymat de-icing, a front fin-post, a stub rear-post, chordwise sheet-ribs and a flush-riveted skin. Each fin is anchored to the stub portion by three pin-joints, the two forward pins accommodating bending moments and the rear pin bearing the shear loads.

[Continued overleaf

ARGOSY PRODUCTION AND INSPECTION

These engineers are in charge of the manufacture and inspection of the Argosy, and have supervised an exceptionally tight schedule. On the right are T. Baylis, works manager and, far right, J. Hosie, production manager. Below, left to right, are J. A. Butter, quality manager; J. Maguire, chief inspector; L. W. Brown, works superintendent; S. Fairlie, chief production engineer (assembly); E. H. Harrison, production controller; and P. A. Courtman, P.A. to the general manager.



The AW.660 is basically similar to the 650, but a beaver-tail rear loading door and ramp take the place of the after freight-door of the civil version. This illustration has been prepared from a model.

ARGOSY . . .

Construction of ailerons, rudders and elevator is also perfectly straightforward, each assembly having a channel-section spar and pressed ribs, the light skinning on the elevator, rudders and their tabs being stiffened by pressed chordwise fluting. All surfaces are manually operated by a mixture of push/pull-rods and cables, and Teleflex tension regulators are employed. Each wing has three sections of shrouded and beak-nosed aileron, the centre and outer portion of aileron having a spring servo tab and the innermost portion a trim/geared tab on the port wing and a geared tab on the starboard. The elevator is built in port and starboard halves, each of which carries separate trim, spring servo and geared tabs; large horn-balances are provided outboard of the fins. The rudders carry large trim/geared tabs, and small spring-servo tabs at their lower ends.

All three units of the undercarriage retract rearwards. Extension of the main gear takes the form of a controlled free-fall action, following hydraulic release of the up-locks, a jack on the breaker strut ensuring positive locking in the down position. Each unit consists of a pair of brackets forged in High Duty Alloys RR.77 (D.T.D. 683 light alloy) pivoted beneath the inboard engine ribs, and carrying at their lower extremities trunnions at the upper end of the main leg forging in the same material. Within the latter is a Dowty air/oil strut, bearing the transverse axle and twin wheels. The unit is braced in the extended position by a large radius-rod, to which is attached the forward end of the breaker strut and linkages to the two forward leg doors. Dunlop wheels, multi-cylinder brakes (with non-organic pads) and tubeless tyres are fitted.

The nose gear is exceedingly small by comparison. It is extended under positive hydraulic power, and its twin wheels are mounted on a fixed axle which can be steered hydraulically through ±45 deg. Owing to the relatively restricted depth available for the beams beneath the cargo floor, those to which the nose-undercarriage trunnions are bolted are fabricated in steel; in fact, the practicability of mounting the nose gear on either the port or starboard side of the fuselage was extensively investigated, with a view to reducing the bending moment on these beams. Owing to the very small ground clearance, the twin doors covering the unpressurized bay into which the unit retracts are arranged to swing upward into spaces left by adjacent doors further outboard (as shown in a detail sketch on page 627).

For the present, at least, the standard powerplants will comprise Rolls-Royce Dart Mk 526 turboprops (RDa.7/2 rating), installed as complete packages virtually identical with those of the latest Viscounts. The RDa.7 engine itself is now well known and was described in our issue of February 28 last. The main mounting points are located at either side and on top of the rear compressor casing, and from these three points a triple-vee frame extends rearwards to the four anchorages carried by the tubular structure built out from the heavy engine ribs and main spar. The main firewall is a stainless-steel bulkhead which marks the demarcation between the power package and the remainder of the airframe; an additional fireproof bulkhead around the compressor casing separates Zones 1 and 2, and a Refrasil blanket and light-alloy shroud surrounds each of the jet-pipes, which are relatively short and eject from the lower outboard side of each nacelle. Vickers manufacture the bulged petal-type cowlings, and the fixed intake periphery is provided with Dunlop electric de-icing elements.

Rotol 11ft 6in propellers are used, with four forged light-alloy blades. Driven through a reduction gearbox of 0.093:1 ratio, this propeller has a hub and spinner similar to that of the Friendship, electric de-icing, and provision for synchronizing, constant-speeding, feathering and reversing. A Rotol accessory gearbox is mounted above each jet-pipe in a steel box, the drive shaft passing through both this box and the firewall to the engine power-offtake. The engine oil tank is integral with the air-intake casing.

Standard fuel for the Argosy will be aviation kerosine to D.Eng. R.D.2482. A total of 3,300 Imp. gal (3,963 U.S. gal) is accommodated in ten flexible cells (by Fireproof Tanks) disposed at intervals between the spars of the wing. The outer three tanks in each wing are connected to feed the outboard powerplants, the inner engines being fed from the two inboard tanks in each wing; in emergency, of course, any engine can be fed from any tank. The system can be pressure-fuelled or de-fuelled from a socket on the radius rod of each main undercarriage, either socket being rated at 150 Imp. gal/min. Provision is also made for gravity over-wing fuelling. Each fuel cell lies in a smooth bay formed from a light-alloy skin wrapped round the inner periphery of the tank-bay ribs, and either of the two submerged booster pumps in each tank can be withdrawn through the sump without draining the tank's contents. In adverse conditions of altitude and/or temperature, power can be restored by a water/methanol system fed from a 68 Imp. gal rigid tank in each boom. These tanks also are fuelled from sockets on the undercarriage radius rods.

Most of the main power services—undercarriage, undercarriage doors, steering, flaps, wheel brakes and, in production aircraft, the cargo doors—are operated hydraulically. The system operates at a working pressure between 2,500 and 3,000 lb/sq in and is energized by Lockheed Mk 9 pumps driven off engines 1, 2 and 3. Ordinary mineral oil (D.T.D. 585) is used, the reservoir being mounted in the port tail boom and pressurized at between 10 and 12 lb/sq in from the cabin-blower delivery. A centralized servicing bay is located in the port side of the fuselage, and emergency operation is effected by an Integral electrically-driven powerpack located under the cargo floor. Small self-contained hydraulic systems work the windscreen wipers and locking latches around the cargo doors; a hydraulic motor will also be incorporated in production machines for opening and closing these doors.

A 28-V D.C. electric system is employed for basic power generation, each accessory gearbox driving a Rotax 6-kW generator and three 25-Amp.-hr Varley batteries being mounted on the port side of the fuselage. Inverters are used to supply three-phase and single-phase services at 115 V, 400 c/s. Raw A.C. (frequency-wild) for de-icing purposes is required in even greater quantities, and each accessory gearbox accordingly drives a Rotax 22.5-kVA alternator for this purpose. These machines feed three-phase current at 208 V, 400 c/s.

Drawings on pp. 630-632 provide an outline of the functioning of the air-conditioning system. A Godfrey Type 15 Mk 9 blower is driven from engines 1, 2 and 4, any two blowers being capable of meeting all demands. Maximum pressure differential is 5.5 lb/sq in, providing a cabin height of 8,000ft at a true altitude of 25,000ft. The cold-air unit is a Godfrey C.A.7 Mk 5D and this, with the Marston primary and secondary heat-exchangers and other centralized units, is mounted in the equipment bay aft of the flight deck. A maximum of 100 lb/min of conditioned air can be fed through a glass-fibre duct at roof level, passing out of the hold and exhausting at the front and rear discharge-valves. Special supplies are provided for the crew, and hot air for windscreen demisting is fed by small Airscrew blowers.

De-icing of the mainplane is accomplished by hot air. Fresh air is rammed in through scoops on the inboard side of each inner nacelle and heated by lightweight Delaney Gallay heat exchangers through which a proportion of the efflux from the inboard engines may be diverted by extending a retractable scoop into the jet-pipe. The diverted gas issues from a separate orifice on the inboard side of each inner nacelle, and the heated air is ducted at 170 deg C through the double-skinned leading edge and exhausted through outlets flush with the upper forward surface of the wing at various points along the span. The complete tail unit, including elevator horn balances, is protected by Napier Spraymat cyclic-electric pads. Dunlop rubber cyclic-electric protection is provided around the engine and oil-cooler intakes, and electric heater elements are also rebated into the inboard portions of the propeller blades. The three central panels of the windscreen are of Nesa glass, supplied with current at either 270 or 410 V, according to the position of a manual switch. Compressor-bleed air is used to heat the fuel filters. All ice protection can be placed under automatic control, governed by ice detectors on the underside of the forward cargo door.

A simple emergency gaseous-oxygen system is fitted to provide a crew of three with sufficient oxygen for two hours' flying at 25,000ft. The system is served by a single Mk 10 cylinder of 2,250 litres capacity charged at 1,800 lb/sq in. A British Oxygen Aro Equipment diluter demand-regulator, Type A-12A, is pro-

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on its successful maiden passenger flight—a round-trip to New York and back. B.O.A.C. rely on AeroShell Turbine Fuel and Shell Aviation Service.

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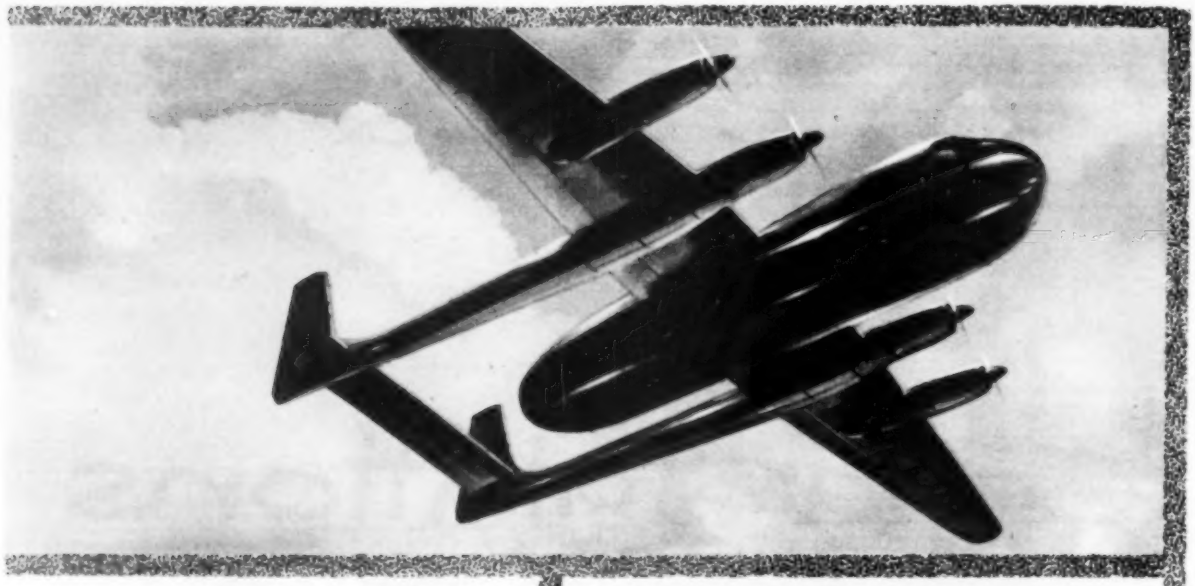

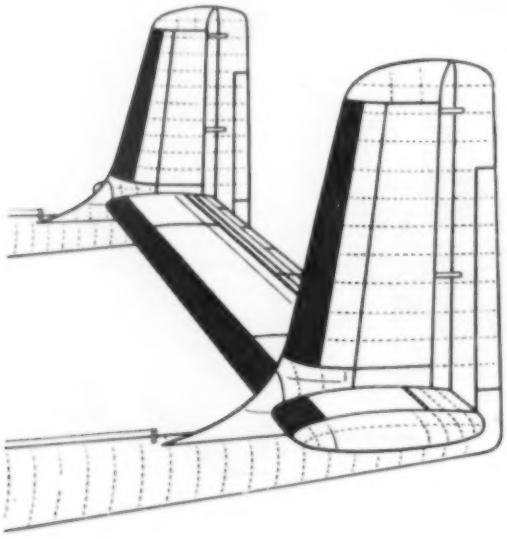

NAPIER SPRAYMAT de-icing equipment chosen for A.W650

The 'Spraymat' ice protection system on the Argosy has been designed to meet the latest C.A.A. and A.R.B. requirements and is equipped with a number of built in safety features, including the Napier 'Stoneguard' protective coating and Napier overheat control units. A total power requirement of only 20 k.v.a. gives complete protection to the tail empennage. The area of the heated surfaces is 100 sq. ft.

Spraymat has also been chosen for:—

Canadair ARGUS
Blackburn BEVERLEY
Sud Aviation CARAVELLE
de Havilland COMET
Canadair 540
Fokker FRIENDSHIP
Bristol BRITANNIA
Fairey GANNET
Fairey ROTODYNE
Avro SHACKLETON
Vickers VANGUARD
Handley Page VICTOR
Avro VULCAN

and numerous other projects both in Europe and the North American Continent.

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vided for each crew member. Fire protection is achieved by hand extinguishers and by four Graviner 12-lb methyl-bromide bottles serving the powerplants and accessory gearbox bays.

Instrumentation is in no way particularly unusual, although the complete flight-deck has been most carefully laid out with the close co-operation of the B.A.L.P.A. and other interested parties. Shown in detail in a drawing on pp. 630-631, comfortable accommodation is provided for two pilots and for a third crew-member in a swivelling seat. Standard equipment includes the Smiths Flight System, a Smiths SEP.2 autopilot and Simmonds Pacitor Type 2 fuel and water/methanol gauges. Radio and navigation equipment is, of course, partly a matter for customer preference; but provision is made for duplicated Standard STR.12D V.H.F., STR.18C H.F., Ultra UA/17 intercom, duplicated Marconi AD.712 A.D.F., SR.32 VOR./I.L.S. and an SR.33 marker receiver. The positions of most of the aerials are denoted in our main cut-away drawing. Provision is also made for a search radar in the forward cargo door (the Ekco E.160 being suggested), and for a Decca Navigator Mk 10 and Flight Log and a Kelvin Hughes Type 1A periscopic sextant.

In all versions of the AW.650, passengers (when carried) will be accommodated at the rear. Normal seating will be six-abreast, each triple seat unit being arranged to hinge upwards about its outboard attachment pins, the inner ends being provided with latches engaging with the underside of the baggage racks. By this means a section of fuselage equipped for passenger transport can be switched to freight in a few minutes and the seats retained on board. Normal seating in the all-passenger rôle is 77 at 34in pitch and 83 at 32in pitch; with only six rows of seats installed, 188 sq ft of floor space remains available for cargo. Passenger and freight sections may be separated by a readily movable bulkhead pinned to the fuselage frames; in the first aircraft this is made of plywood with a polyurethane foamed filler, but in future machines a Reduxed metal honeycomb may be used. Other non-structural bulkheads may be employed for passenger furnishing, and readily removable passenger-amenity units have been designed, a typical configuration being depicted on p. 632.

From the foregoing it is evident that the basic AW.650 promises to be a thoroughly sound piece of engineering, with exceptional commercial attractions. At a later date it will be joined by the 660/661 military freighter and the capacious and unpressurized 670/671 aircraft. At the moment, however, all ten aircraft under construction are basically identical AW.650s and their production has been most carefully planned and is at present on schedule.

It is worth noting that, perhaps partly owing to the fact that the programme is under the complete control of the Hawker Siddeley Group and is not dependent on the whims of customers or changing military requirements, the elapsed time between the first release of drawings and the roll-out of the first completed aircraft promises to be exceptionally short—in fact, it may well be a record for any aircraft of such size and weight. The 27-month fabrication cycle for the first aeroplane is to be progressively tightened until the final cycle is scheduled to occupy exactly one year from the start of manufacture of details to delivery to the flight shed. As one might expect from so production-conscious a firm as A.W.A., collaboration was very close between the design and production departments from the inception of the project. A.W.A. are now in a position to plan future production, delivery times and prices with a satisfactory degree of assurance and accuracy.

Several weeks ago this fuselage, the second off the line at Baginton, was taken to the new testing facility at Whitley, for static (not fatigue) testing in the 150,000-gal water tank seen in the background.

At present the first Argosy, G-AOZZ, is approaching completion in the flight shed at Bitteswell and, following vibration tests and taxying trials, it should fly well before the end of the year. The remaining nine are coming through on schedule and all should be flown before the end of 1959. A complete airframe is being fatigue-tested in a water tank at the company's design centre at Whitley. There are actually two tanks and a new office block, forming an exceptionally efficient establishment in which specimens can be installed and removed and the tanks filled and emptied with unparalleled rapidity. For this particular airframe a flight plan has been selected for a 500 n.m. stage, involving a high incidence of undercarriage loads and gust cycles as well as full pressurization. In contrast, the static-test airframe is not completely assembled. Instead, the fuselage is being tested to destruction at Whitley while the wings, tail booms and empennage are being investigated at the Avro facility at Woodford, Cheshire.

Three machines will be used during the certification programme. Structural integrity will be investigated from the very first flight of G-AOZZ; extensive strain-gauging is already being installed on the swinging wing/fuselage links, flap torque-tubes, intermediate/outer-wing joints and tailplane attachment joints, and 24 accelerometers are also being installed. Temperatures throughout the aircraft—including multiple points in the cabin-air and wing de-icing systems, and even the temperature of the alternator rotors—will be measured and recorded by a 240-channel Honeywell continuous-strip chart recorder. Armstrong Whitworth have laid down a rigorous flight-test schedule which calls for the completion of all tests for both C.A.A. and A.R.B. certificates by mid-1960. The progress of this schedule will be reported upon in due course.

CONTRIBUTORS TO THE ARGOSY

The following lists of sub-contractors and suppliers of materials, components and details have been provided by the manufacturers of the aircraft:—

Materials

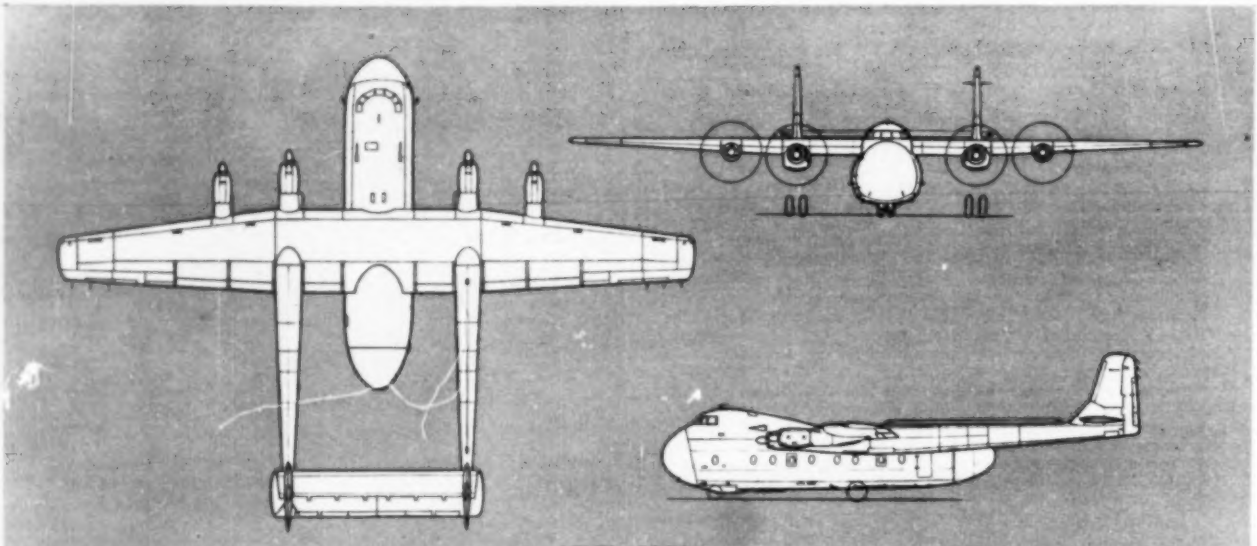
Accles and Pollock, Ltd.; Aluminium Wire and Cable, Ltd.; B. Attewell and Sons, Ltd.; B.X. Plastics, Ltd.; Birmetals, Ltd.; Birmingham Aluminium Casting (1903) Co., Ltd.; T. Bolton and Sons, Ltd.; J. Booth and Co., Ltd.; Brett's Stampings Co., Ltd.; Brifex, Ltd.; British Aluminium Co., Ltd.; British Insulated Callender's Cables, Ltd.; British Plywood Manufacturing, Ltd.; British Ropes, Ltd.; Brown Bayley Steels, Ltd.; C. G. Carlisle and Co., Ltd.; C. Clifford, Ltd.; W. B. Cull and Sons, Ltd.; Dunlop Rubber Co., Ltd.; English Steel Rolling Mills Corporation, Ltd.; Ferodo, Ltd.; T. F. Firth and Sons, Ltd.; Thos. Firth and John Brown, Ltd.; Firth-Vickers Stainless Steels, Ltd.; W. T. Flather, Ltd.; Fothergill and Harvey (Sales), Ltd.; Samuel Fox and Co., Ltd.; Glynhir Tinplate Co., Ltd.; Govan Shafting and Engineering Co., Ltd.; Greenwich Plastics, Ltd.; Hall and Hall, Ltd.; High Duty Alloys, Ltd.; Imperial Chemical Industries, Ltd.; Ioco, Ltd.; J. F. Kenure, Ltd.; Kiveton Park Steel and Wire Works, Ltd.; R. Klinger, Ltd.; Northern Aluminium Co., Ltd.; Polypenco, Ltd.; Reynolds Tube Co., Ltd.; J. W. Roberts, Ltd.; Rotherham Forge and Rolling Mills Co., Ltd.; Southalls (Birmingham), Ltd.; Stampings Alliance, Ltd.; Sterling Metals, Ltd.; Talbot Stead Tube Co., Ltd.; Transport Seating, Ltd.; Tufnol, Ltd.; Tungum Co., Ltd.; James Walker and Co., Ltd.; Walsh and McCrea (Halifax), Ltd.; Benjamin Whittaker, Ltd.; Wilkinson Rubber Linatex, Ltd.; Yorkshire Imperial Metals, Ltd.

Sub-contractors

A.B. Metal Products, Ltd.; A.E.I. Lamp and Lighting Co., Ltd.; Aero Controls, Ltd.; Airscrew Co. and Jicwood, Ltd.; George Angus, Ltd.; Appleby and Ireland, Ltd.; Avery Hardoll, Ltd.; Aviation Developments, Ltd.; Avo, Ltd.; Belling and Lee, Ltd.; Birmingham and Blackburn Construction Co., Ltd.; Thos. Boorn and Co., Ltd.; British Oxygen Aro Equipment, Ltd.; British Refrasil Co., Ltd.; British Timken, Ltd.; British Thomson-Houston Co., Ltd.; British Wire Products, Ltd.; Brush Electrical Engineering, Ltd.; Budenburg Gauge Co.; A. F. Bulgin, Ltd.; Burgess Products, Ltd.; Cambridge Instruments, Ltd.

Camerer Cuss, Ltd.; Cannon Electric (G.B.), Ltd.; Cementation (Muffelite), Ltd.; Chelton (Electrostatics), Ltd.; CIBA (A.R.L.), Ltd.; H. Comoy and Co., Ltd.; G. Corner and Co., Ltd.; Cornercroft, Ltd.; C.W.C. Equipment, Ltd.; Dart Spring Co., Ltd.; Decca Navigator Co., Ltd.; Delaney Gallay, Ltd.; Dependable Springs and Pressings, Ltd.; Dover, Ltd.; Dowty Equipment, Ltd.; Dowty Nucleonics, Ltd.; Dowty Seals, Ltd.; Dunlop Rubber Co., Ltd.; Ekco Electronics, Ltd.; Elliott Brothers (London), Ltd.; Erith Eng. Co. (Leicester), Ltd.; Fairey Aviation Co., Ltd.; Ferranti, Ltd.; Denis Ferranti (Meters), Ltd.

Films and Equipment, Ltd.; Fireproof Tanks, Ltd.; Firth Cleveland Instruments, Ltd.; Flight Refuelling, Ltd.; General Electric Co., Ltd.; Gent and Co., Ltd.; Gloster Aircraft Co., Ltd.; Sir George Godfrey and Partners, Ltd.; G.Q. Parachute Co., Ltd.; Graseby Instruments, Ltd.; Graviner Manufacturing Co., Ltd.; Griflex Products, Ltd.; Hall and Hall, Ltd.; Harley Aircraft Landing Lamps, Ltd.; Hendrey Relays, Ltd.; W. Henshall and Sons, Ltd.; Hickman, Ltd.; High Pressure



AW.650 ARGOSY

(Four 3,400 e.h.p. Rolls-Royce Dart 526 turboprops)

Dimensions: Span, 113ft; overall length, 86ft 9in; height, 27ft; main wing chord, 12.68ft; gross wing area, 1,458 sq ft; fuselage length, 69ft 7in; maximum width, 150in; cargo floor area, 426 sq ft; gross hold volume, 3,680 cu ft; gross area of horizontal tail, 327 sq ft; gross area of each vertical tail, 125 sq ft; track between main legs, 32ft 6in; wheelbase, 25ft 3.2in.

Weights: Total structure, 27,580 lb (wing 10,800, fuselage 8,750, booms 2,350, empennage 1,380, main undercarriage 2,680, nose undercarriage 500, nacelles 1,280); powerplant group, 10,830 (including 5,240 for engines and 1,900 for propellers and spinners); equipment and furnishings, 8,010 (including 1,900 for electrics and 1,000 for ice protection); crew (2) and baggage, 380; basic operating weight (sum of foregoing), 46,800 lb; disposable load, 34,000 lb; capacity fuel, 26,400 lb; maximum payload (limited by zero-fuel), 28,000 lb; zero-fuel limit, 74,000 lb; maximum landing weight, 78,000 lb; maximum take-off weight, 82,000 lb. Design diving speed (manoeuvring factor 2.5) is 291 kt from s.l. to 15,000 ft.

Estimated performance: (at 82,000 lb, sea level, I.S.A., unless otherwise stated): balanced field length, 4,080ft; field length at 4,000ft at I.S.A. + 20 deg C, 5,630ft; initial rate of climb, 950ft/min at 13,600 r.p.m. or 1,330ft/min at 14,000 r.p.m.; climb performance at 75,000 lb at 13,600 r.p.m., 30½ min to 20,000ft in 90 n.m. consuming 1,740 lb fuel; at 14,000 r.p.m. to same height, 23½ min in 73 n.m. consuming 1,455 lb fuel; cruise at 75,000 lb at 13,600 r.p.m., 252 kt at 10,000ft at 0.068 n.a.m./lb fuel or 242.5 kt at 20,000ft at 0.0885 n.a.m./lb; cruise at 75,000 lb at 14,000 r.p.m., 263 kt at 10,000ft at 0.0665 n.a.m./lb or 258 kt at 20,000ft at 0.0872 n.a.m./lb; approach speed at 75,000 lb, 98 kt; unfactored landing distance from 50ft at same weight, 2,400ft.

Estimated economics: a typical AW.650, without spares, is currently priced at about £450,000; payload (normal allowances, no reserves) is 28,000 lb out to 620 n.m. and thereafter drops to 9,500 lb at 2,390 n.m.; D.O.C. (pence per 2,000-lb statute mile, A.T.A.) is about 8 at 300 miles, and 7 between 500 and 1,000 miles.

ARGOSY . . .

Components, Ltd.; H. M. Hobson, Ltd.; Hoffmann Manufacturing Co., Ltd.; Honeywell Controls, Ltd.; A. H. Hunt (Capacitors), Ltd.

Integral, Ltd.; E. J. Jack, Ltd.; R. Klinger, Ltd.; King Aircraft Corporation (K.A.C.), Ltd.; Lockheed Hydraulics, Ltd.; Magnetic Devices, Ltd.; Manganese, Bronze and Brass, Ltd.; Marconi's Wireless Telegraph Co., Ltd.; Maricon, Ltd.; Marston Excelsior, Ltd.; Measuring Instruments (Pullin), Ltd.; Mechanism, Ltd.; M.B. Metals, Ltd.; Midland Aeroquipment, Ltd.; Mollart Engineering, Ltd.; N.S.F., Ltd.; D. Napier and Son, Ltd.; National Physical Laboratories, Ltd.; Negretti and Zambra, Ltd.; Neil Tool Co., Ltd.; Newton Brothers (Derby), Ltd.; Normalair, Ltd.; Norman Engineering, Ltd.; Northern Rubber, Co., Ltd.

Phœnix Telephone and Electric Works, Ltd.; Philips Electrical, Ltd.; Pianoforte Supplies, Ltd.; Pittsburgh Plate Glass Co.; Plannair, Ltd.; Plessey Co., Ltd.; A. Poole and Sons, Ltd.; Power Controls, Ltd.; Pulsometer Engineering Co., Ltd.; Pyrene Co., Ltd.; Ransome and Marles Bearing Co., Ltd.; Regent Small Tools, Ltd.; Renold Chains, Ltd.; A. V. Roe and Co., Ltd.; Rolls-Royce, Ltd.; Rose Brothers (Gainsborough), Ltd.; Rotax, Ltd.; Rotol, Ltd.; L. A. Rumbold and Co., Ltd.

Sangamo Weston, Ltd.; Santor Ltd.; Saunders-Roe, Ltd.; Saunders Valve Co., Ltd.; SPE Co., Ltd., Short Brothers and Harland, Ltd.; Siebe Gorman and Co., Ltd.; Simmonds Aerocessories, Ltd.; Silentbloc, Ltd.; Skefco Ball Bearing Co., Ltd.; Smiths Aircraft Instruments, Ltd.; Standard Telephones and Cables, Ltd.; J. Stone and Co. (Deptford), Ltd.; Tecalemit, Ltd.; Teddington Aircraft Controls, Ltd.; Teleflex Products Ltd.; Telegraph Construction and Maintenance, Ltd.; Thorn Electrical Industries, Ltd.; H. Tinsley, Ltd.; Torrington Co., Ltd.; Transport Seating, Ltd.; Triplex Safety Glass Co., Ltd.; Ultra Electric, Ltd.; Vandervell Products, Ltd.; Varley Dry Accumulators, Ltd.; Venner, Ltd.; Vickers-Armstrongs (Engineers), Ltd.; Vokes, Ltd.; Welwyn Electrical Laboratories, Ltd.; Western Manufacturing (Reading), Ltd.

THE OTHER ARGOSY

Dating from 1926, this grand old A.W.A. aeroplane carried twenty passengers. Its three engines were 14-cylinder radial Jaguars, made by Armstrong Siddeley; and a fleet operated on the London - Paris service of Imperial Airways until 1933. It makes an interesting comparison with its successor of 32 years later; data for the machine shown (with ungeared engines of 385 h.p.) include the following: span, 90ft 4in; length, 64ft 6in; wing area, 1,890 sq ft; payload 4,500 lb; gross weight, 18,000 lb; and cruising speed, 95 m.p.h.

79 A.D.F. sense
80 V.O.R.
81 H.F.

Wing structure and Flaps

82 Front-spar section
83 Rear-spar section
84 Hinged leading edge
85 Hinged access panels
86 Wing skin 16 s.w.g.
87 Tank access panels
88 Fuselage-frame anchorage on spar neutral axis
89 Aerofoil N.A.C.A. 23018 (modified) root, 23012 tip
90 Centre/intermediate wing joint
91 Intermediate/outer wing joint
92 Detachable tip
93 Tank-bay inner skin
94 Access to No. 3 tank fuel pumps
95 Fuel-water drain panels

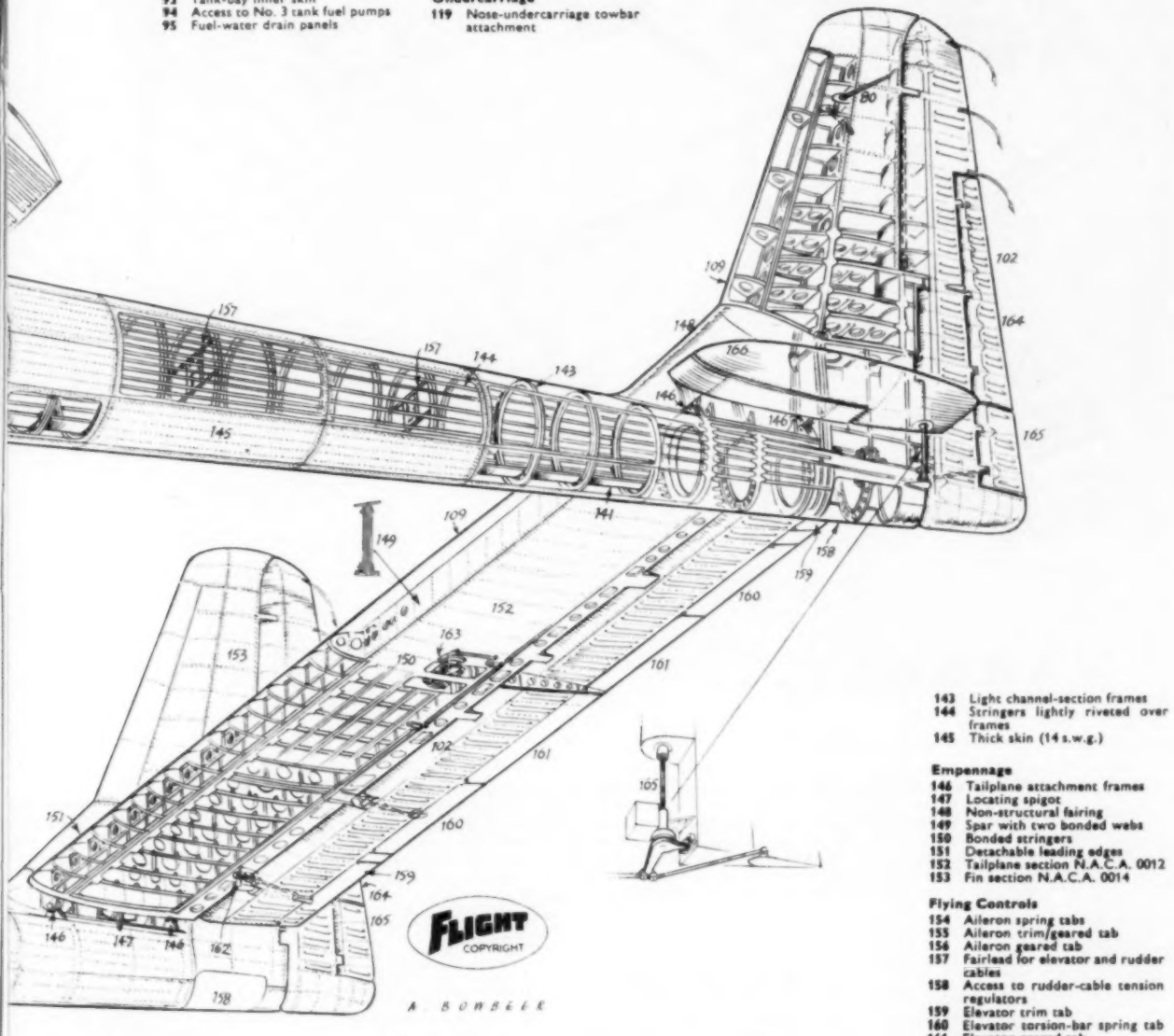
108 Warm-air exhaust
109 Spraymat electric de-icing on empennage

Powerplants

110 Airflow through oil cooler
111 Engine air intake
112 Accessory gearbox above jet-pipe
113 Inter-zone firewall
114 Firewall (marking rear limit of Viscount-type power package)
115 Fire access panels
116 Cooling air to Zones 1 and 2
117 Cooling air to generator
118 Electrically heated spinner and intake

Undercarriage

119 Nose-undercarriage towbar attachment



FLIGHT
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A. BOWBEER

143 Light channel-section frames
144 Stringers lightly riveted over frames
145 Thick skin (14 s.w.g.)

Empennage

146 Tailplane attachment frames
147 Locating spigot
148 Non-structural fairing
149 Spar with two bonded webs
150 Bonded stringers
151 Detachable leading edges
152 Tailplane section N.A.C.A. 0012
153 Fin section N.A.C.A. 0014

Flying Controls

154 Aileron spring tabs
155 Aileron trim/geared tab
156 Aileron geared tab
157 Fairlead for elevator and rudder cables
158 Access to rudder-cable tension regulators
159 Elevator trim tab
160 Elevator torsion-bar spring tab
161 Elevator geared tab
162 Trim-tab screw-jack
163 Elevator-cable tension regulator
164 Rudder trim/geared tab
165 Rudder torsion-bar spring tab
166 Elevator horn balance

Fuel System

167 Flexible fuel cells between spars
168 Water/methanol tank, 68 Imp. gal in each boom
169 Pressure fuelling/defuelling socket on each main-under-carriage radius rod
170 Pressure fuelling sockets for water/methanol system
171 Refuelling switch panels on aft face of fairing door
172 No. 1 tank, 362 Imp. gal
173 No. 2 tank, 463 Imp. gal
174 No. 3 tank, 405 Imp. gal
175 No. 4 tank, 320 Imp. gal
176 No. 5 tank, 100 Imp. gal

lves
delivery duct
r intake from

15 blowers
4)

nd filters

96 Secondary structure, made by A.W.A.
97 Hydraulic flap motor, gearbox and transmission
98 Torque tubes
99 Flap attachment ribs
100 Endless chain
101 Roller and guide rail
102 Fluted skin
103 Centre-section flap removed

De-icing

104 Jet-pipe flap valve
105 Ram-air to-heat exchanger
106 Warm air through leading edge
107 Ice detectors

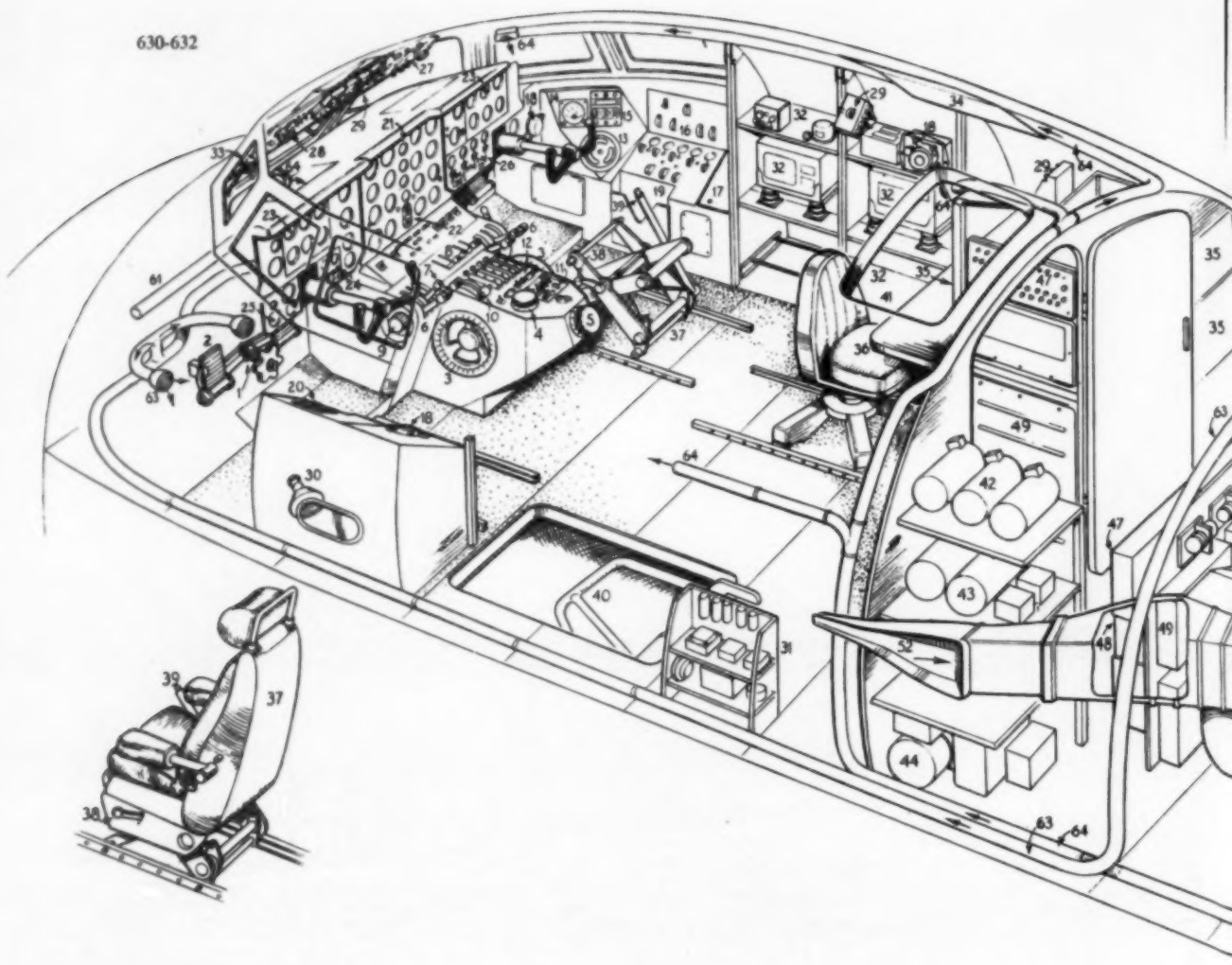
120 Fixed fairing
121 Four interlinked doors
122 Retraction jack
123 Steering motor
124 Tubular support pyramid
125 Radius rod
126 Light-alloy main leg, breaking in centre
127 Breaker strut
128 Spring unit
129 Triple brake pipe
130 Maxaret unit
131 Fairing door and forward leg doors all linked to radius rod
132 Rear doors with sequenced hydraulic operation

133 Main-undercarriage lugs for rearwards towing bridle
134 Nylon ply tyres, 15.50x20

Booms

135 Top mounting on upper boom of rear spar
136 Bottom mounting with tubular bracing
137 Sub-longerons
138 Removable doors
139 Hydraulic header tank
140 Stress-bearing access hatch to 139
141 Catwalk, whole length of boom
142 Junction boxes

630-632



ARGOSY . . .

In order to obtain a completely unobstructed cargo space, the flight deck is raised above the hold, the floor of one forming the roof of the other. Normally the 650 series will be fitted for operation by a crew of two, but optional provision may be made for a third crew-member, on a swivelling seat. The layout depicted above will be typical of the 650, 651, 660 and 661; the fat-fuselage 670 will have a virtually identical flight deck, but the equipment bay will be much smaller owing to the deletion of the cabin pressurization system. The 670 will have an upper deck for payload accommodation, so in this version the fuselage will not taper behind the flight deck but will retain its full section to a point aft of the wing.

Pedals

1 Centre-adjusting rudder pedals
2 Toe brakes

Centre console

3 Elevator trim
4 Rudder trim
5 Aileron trim
6 Engine power levers
7 Ground fine pitch stop removal
8 H.P. cocks
9 Friction adjuster
10 Flap levers
11 Autopilot control panel
12 Engine fire-warning lamps, feathering switches and fuel-datum indicators

Side consoles

13 Nosewheel steering
14 Search radar display
15 Radio selector box
16 Generator control panel
17 Oxygen mask stowage
18 Oxygen demand/diluter unit
19 Map stowage
20 Search radar control panel

Centre panel

21 Engine instruments
22 Undercarriage push-buttons and indicator

Port panel

23 Flight instruments
24 Water/methanol panel
25 Brake pressure gauge

Starboard panel

26 Fuel system diagram, contents gauges and selector panel

Roof panel

27 Cabin pressurization control panel
28 Anti-icing leading-edge temperature indicators
29 Radio control panels and station boxes

Flight deck, general

30 Wing inspection light
31 Fuel-contents oscillator group
32 Smiths Flight System components
33 E2B stand-by compass
34 Roof panel (optional for third crew-member)
35 Radio racks
36 Table and seat for third crew-member
37 Pilot's seat and bare seat frame
38 Fore/aft adjustment
39 Vertical adjustment
40 Hatch and ladder
41 Crew ditching exit

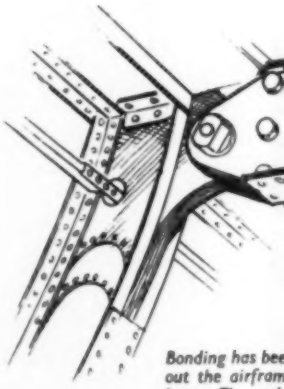
Equipment bay

42 Rotary converters
43 Inverters
44 Motor/generator units and control boxes
45 Four carbon-pile voltage regulators
46 Feathering and de-icing panels
47 Circuit breakers and fuses
48 Three bus-bars
49 Junction boxes

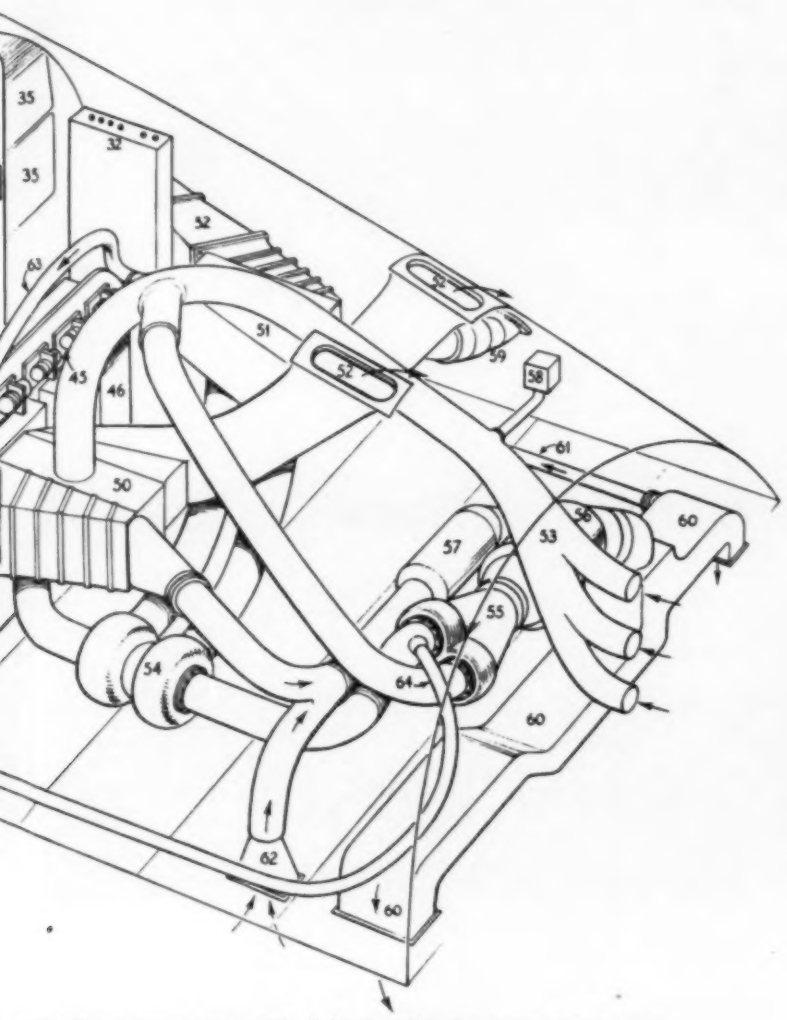
Air-conditioning system (also see separate diagram)

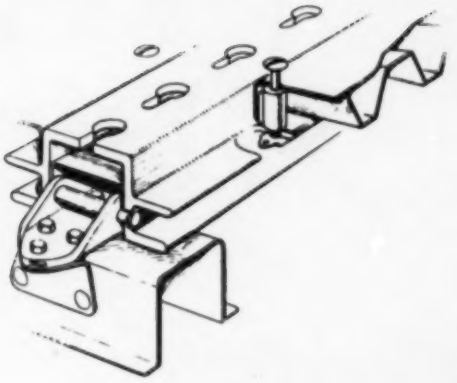
50 Primary heat-exchanger
51 Secondary heat-exchanger
52 Ram airflow through 50 and 51
53 Delivery from three Godfrey blowers
54 Cold-air unit
55 Linked butterfly valves (T in diagram)
56 Secondary silencer
57 Recirculating fan
58 Pressure-limiting switch
59 Pressure-relief valve
60 Conditioned-air delivery duct
61 Conditioned air to flight deck
62 Recirculating air intake from lower deck
63 Warm air to pilots
64 Cool air to pilots and third crew-member

As the large drawing above in the pressurized equipment good. On the right is a sch which are Normalair and Si



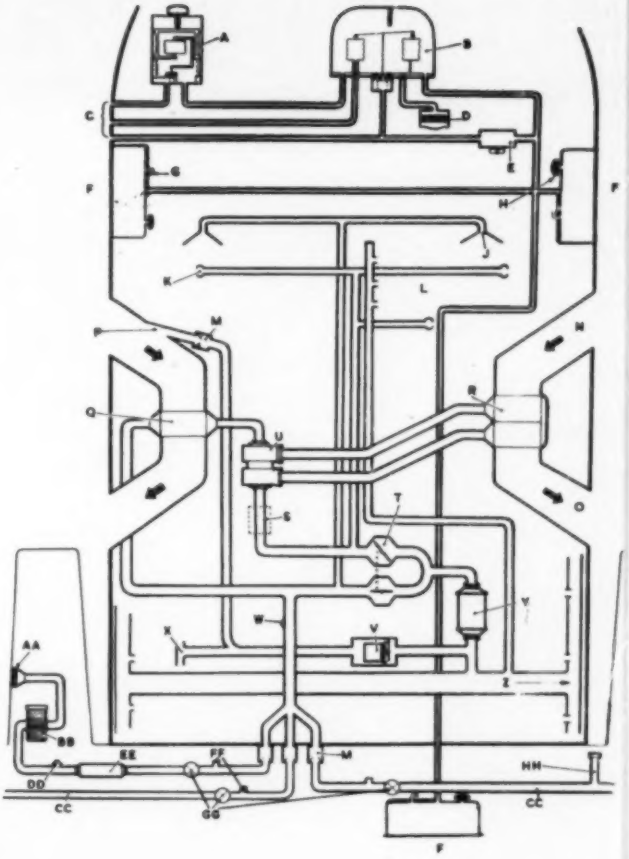
Bonding has bee out the airfram here. The ends comprise pin-j bonded lamina would have bee which would ha points of both c significant adva



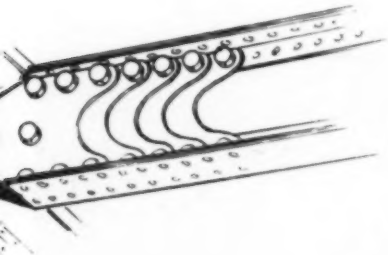


The sketch above illustrates a typical portion of the main cargo floor. The basic structure is built up on transverse Warren girders or plate webs (the former is illustrated) on which is mounted a transverse rail, the spacing corresponding with that of the main fuselage frames. On these are laid six longitudinal rails, each with a form of top-hat section, holes in the top of each rail being provided at two-inch intervals for freight lashing or seat attachments. The floor panels, which are to be bonded sandwiches in production machines, are screwed to the upper flanges of the longitudinal rails.

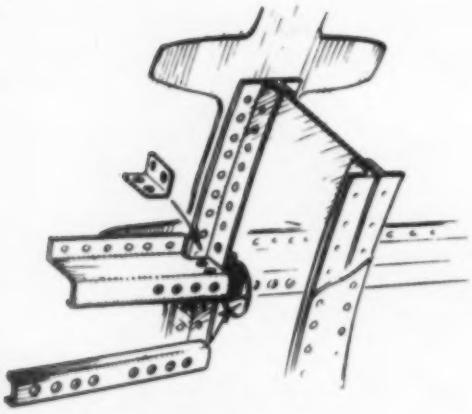
above indicates, several main units of the air-conditioning system are grouped ipment bay to the rear of the flight deck, access for maintenance being outstandingly a schematic diagram of the air-conditioning system, the chief sub-contractors for and Sir George Godfrey and Partners.



A Minimum pressure altitude selector
B Pressure controller
C Static vents
D Air filter
E Dump valve
F Air discharge valves
G To static vents
H Filter
J Foot warmers
K Punkah louvres
L Crew compartment
M Non-return valves
N Cooling air in
O Cooling air out
P Fresh air in
Q Primary heat exchanger
R Secondary heat exchanger
S Water extractor
T Butterfly temperature-control valves
U Cold-air unit
V Recirculating fan
W Pressure-limiting switch
X Recirculation air from side-wall
Y Secondary silencer
Z Cabin distribution ducts
AA Air intake filter
BB Engine-driven blower
CC From outboard blowers
DD Temperature-limiting switch
EE Silencer
FF Spill valve
GG Duct relief valve
HH Ground-test connection

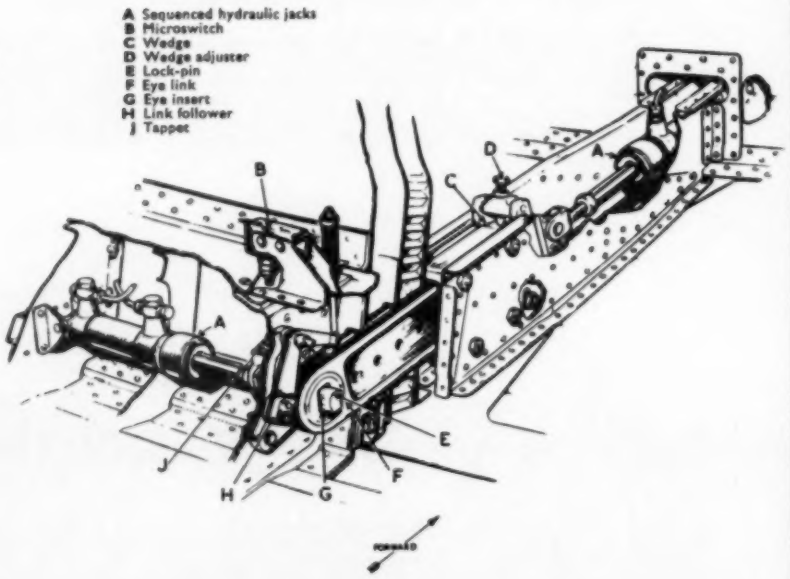


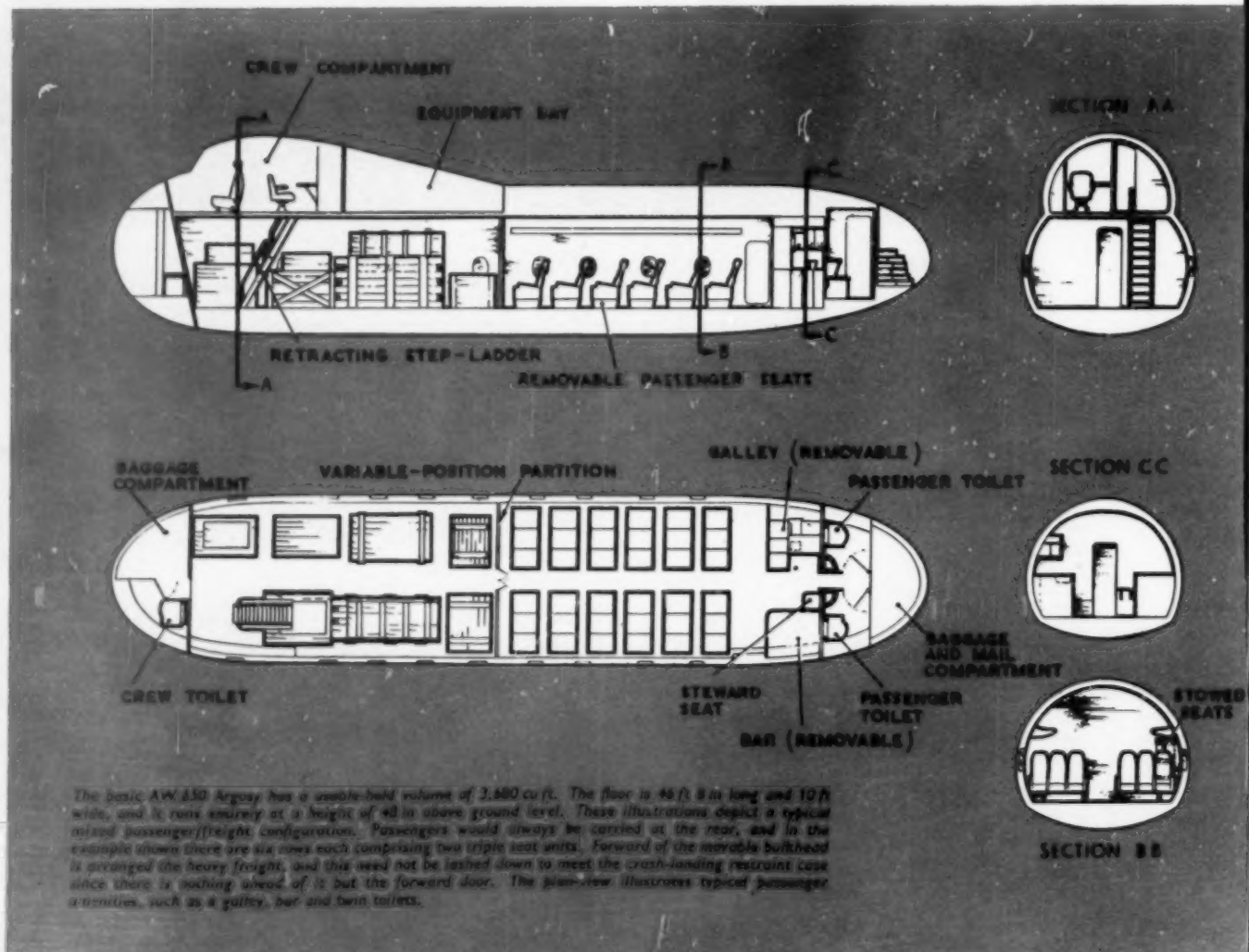
as been employed in localized areas through- irframe, and a typical example is depicted e ends of the main transverse floor beams pin-jointed anchorages built up from aminations of light alloy. The alternative ve been to have used a machined forging, uld have been less desirable from the view- both cost and fatigue life while offering no t advantages.



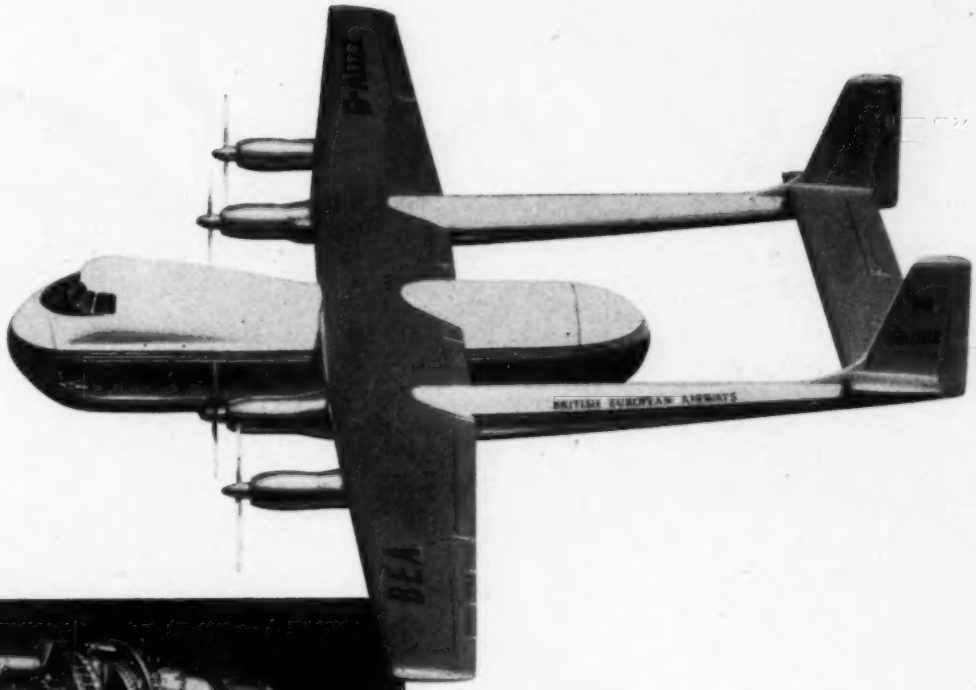
The transverse frames in the Argosy fuselage are not slotted to receive the stringers. Instead, each stringer is broken at each frame-station and is attached to the frame by small angle brackets, the stringer boom being continued by a riveted channel-section passed through a hole pierced in the frame web. Finger plates (doublers) are placed between the skeleton and skin.

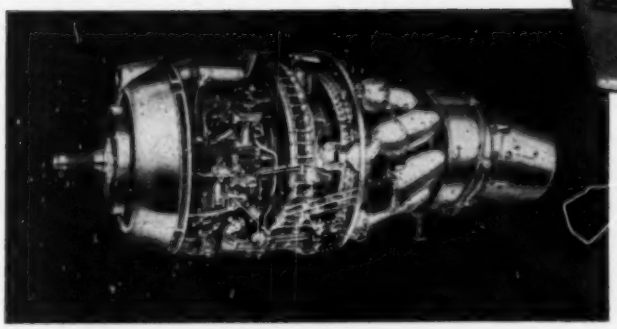
Some of the most difficult design problems of the entire aircraft were those posed by the full-section end doors, which have to withstand the full cabin pressure-differential and must be capable of manual opening and closing. This sketch illustrates one of the multiple latches which secure each door in its closed position; the example chosen is one of the latches for the forward door below the level of the cargo floor. The door-mounted portion of the latch occupies the right-hand half of this drawing.





The basic AW 650 Argosy has a useable-hold volume of 2,680 cu ft. The floor is 46 ft 8 in long and 10 ft wide, and it runs entirely at a height of 4ft above ground level. These illustrations depict a typical mixed passenger/freight configuration. Passengers would always be carried at the rear, and in the example shown there are six rows each comprising two triple seat units. Forward of the movable bulkhead is arranged the heavy freight, and this need not be lashed down to meet the crash-landing restraint case since there is nothing ahead of it but the forward door. The plan-view illustrates typical passenger amenities, such as a galley, bar and twin toilets.





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THE ARMSTRONG WHITWORTH 650 ARGOSY

is powered by

ROLLS-ROYCE

DART PROP-JETS

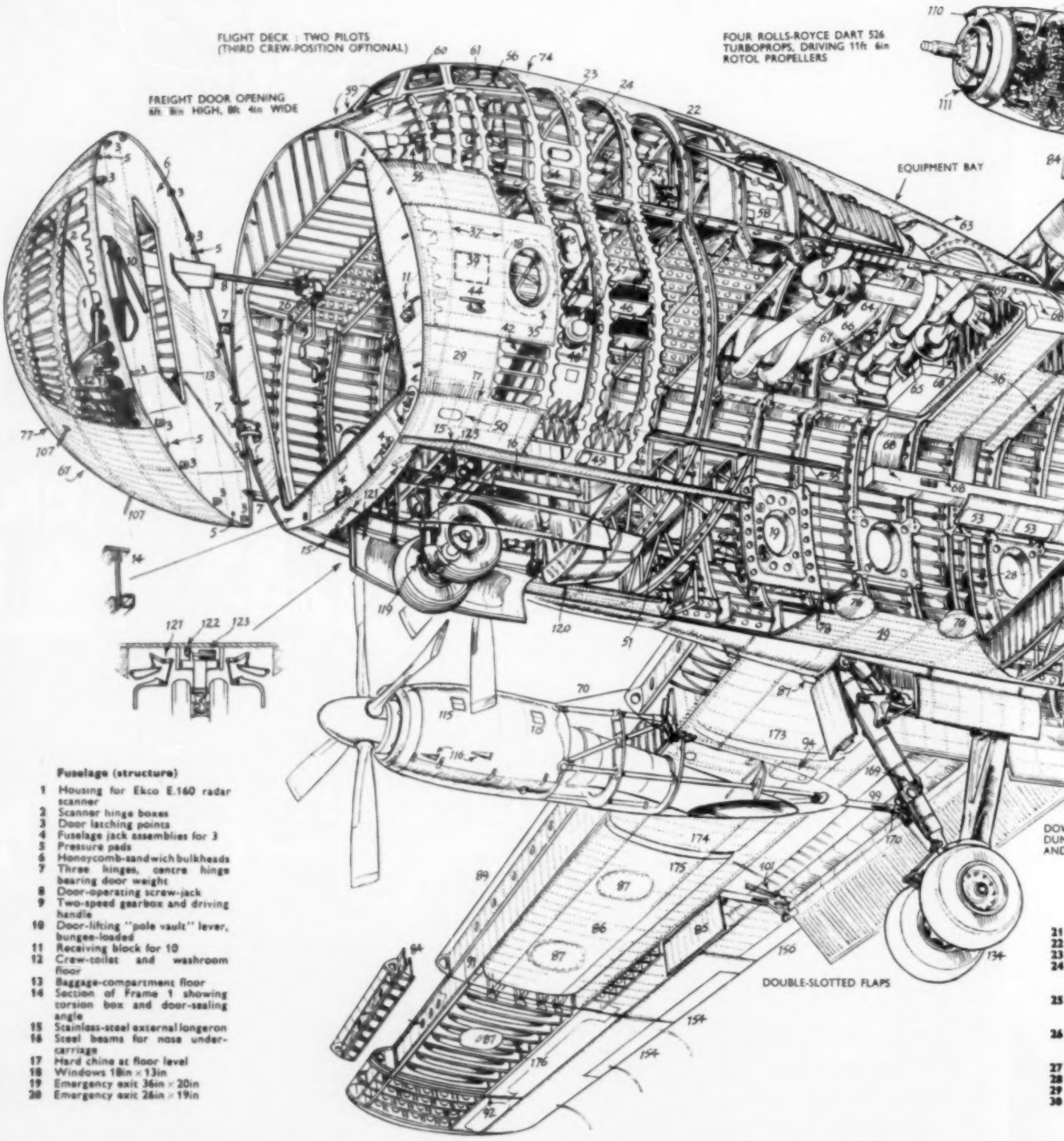
ROLLS-ROYCE LIMITED, DERBY, ENGLAND

AERO ENGINES · MOTOR CARS · DIESEL AND PETROL ENGINES · ROCKET MOTORS · NUCLEAR PROPULSION

ARGOSY . . .

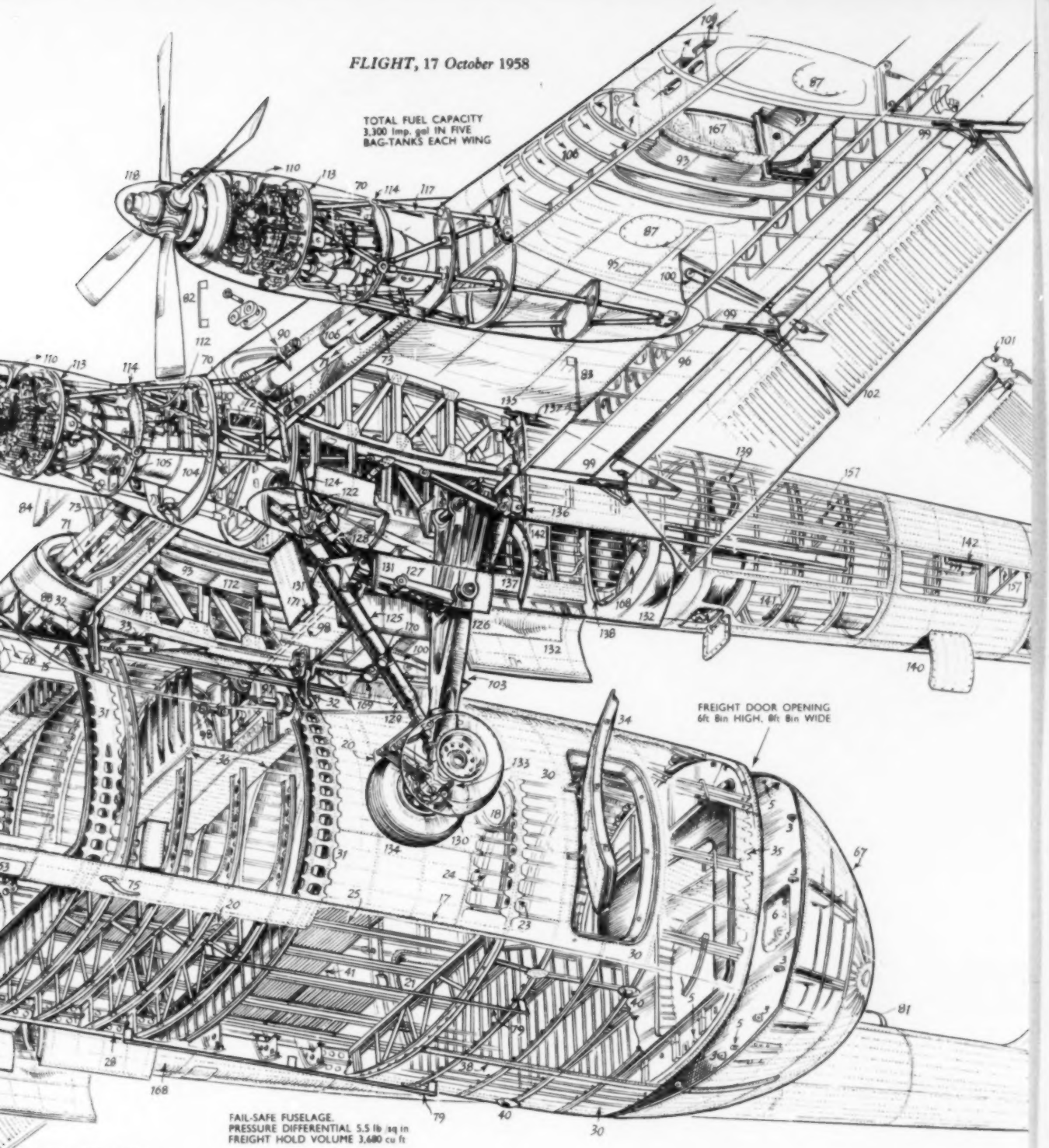
Four 2,100 e.h.p. Rolls-Royce Dart 526 turboprops

This drawing depicts a standard Armstrong Whitworth AW.650 Argosy, ten of which are at present being constructed in production jigs. The structure, to which the manufacturers have accorded quite exceptional attention, is shown in particular detail, and localized areas are the subject of small inset sketches and additional detail drawings on the reverse of this specially prepared sheet. No attempt has been made to illustrate passenger seating; instead, a drawing overleaf depicts a typical mixed passenger/freight configuration for which readily movable bulkheads, galley, bar and two toilet units have been designed.



Fuselage (structure)

1. Housing for Ekco E.160 radar scanner
2. Scanner hinge boxes
3. Door latching points
4. Fuselage jack assemblies for 3
5. Pressure pads
6. Honeycomb-sandwich bulkheads
7. Three hinges, centre hinge bearing door weight
8. Door-operating screw-jack
9. Two-speed gearbox and driving handle
10. Door-lifting "pole vault" lever, bungee-loaded
11. Receiving block for 10
12. Crew-toilet and washroom floor
13. Baggage-compartment floor
14. Section of Frame 1 showing torsion box and door-sealing angle
15. Stainless-steel external longeron
16. Steel beams for nose undercarriage
17. Hard chine at floor level
18. Windows 18in × 13in
19. Emergency exit 36in × 20in
20. Emergency exit 26in × 19in



21 Emergency door
22 Crew-ditching exit
23 "Finger-plate" rip stoppers
24 Intercostal stringers with carry-through channel boom (see detail sketch overleaf)
25 Six longitudinal rails for freight-lashing or seating (see detail sketch overleaf)
26 Reduxed ends to flight-deck floor beams (see detail sketch overleaf)
27 Wall freight-lashing points
28 Skin 17 s.w.g.
29 Skin 19 s.w.g.
30 Skin 21 s.w.g.
31 Double frames to wing spar attachments
32 Swinging lift link
33 Swinging drag link
34 Passenger door
35 Reduxed doublers around cut-outs
36 Pressure bulkheads at spar cut-outs
37 Frames at 21in pitch
38 Fuselage drain gallery
39 Freight-door locking controls
40 Faired pads for Dowty support struts (rear-loading case)
41 Bonded-sandwich floor panels (see detail sketch overleaf)
42 Folding ladder to flight deck
43 Cupboard for 46, 47 and 48

Fuselage (installed equipment)

44 Pitot head (port and starboard)
45 Oxygen bottle
46 Three 25 Amp.-hr Varley batteries
47 Control box
48 Ground air-conditioning connection
49 Oxygen charging points
50 Ground D.C. supply socket
51 Centralized dessicant pack
52 Piping to inter-pane airspace
53 Hydraulic service panels
54 Wing inspection light (amber)
55 Control columns
56 Captain's seat
57 Fuel-contents oscillator group
58 Converters, inverters, control panels
59 Nesa glass, electrically heated panels
60 Direct-vision panel
61 Hot-air demisting
62 Radio racks
63 Airflow through primary heat exchanger
64 Cold air unit
65 Secondary silencer
66 Recirculating fan
67 Air-discharge va
68 Conditioned-air
69 Recirculating a lower deck
70 Godfrey Type (engines 1, 2 an
71 Air from 70
72 Blower intakes
73 Primary silencer

Aerials

74 V.H.F. No. 1
75 V.H.F. No. 2
76 Twin A.D.F. loo
77 I.L.S. glide-path
78 I.L.S. marker

79 A.D.F. sense
80 V.O.R.
81 H.F.

Wing structure and Flaps

82 Front-spar section
83 Rear-spar section
84 Hinged leading edge
85 Hinged access panels
86 Wing skin 16 s.w.g.
87 Tank access panels
88 Fuselage-frame anchorage on spar neutral axis
89 Aerofoil N.A.C.A. 23018 (modified) root, 23012 tip
90 Centre/intermediate wing joint
91 Intermediate/outer wing joint
92 Detachable tip
93 Tank-bay inner skin
94 Access to No. 3 tank fuel pumps
95 Fuel-water drain panels

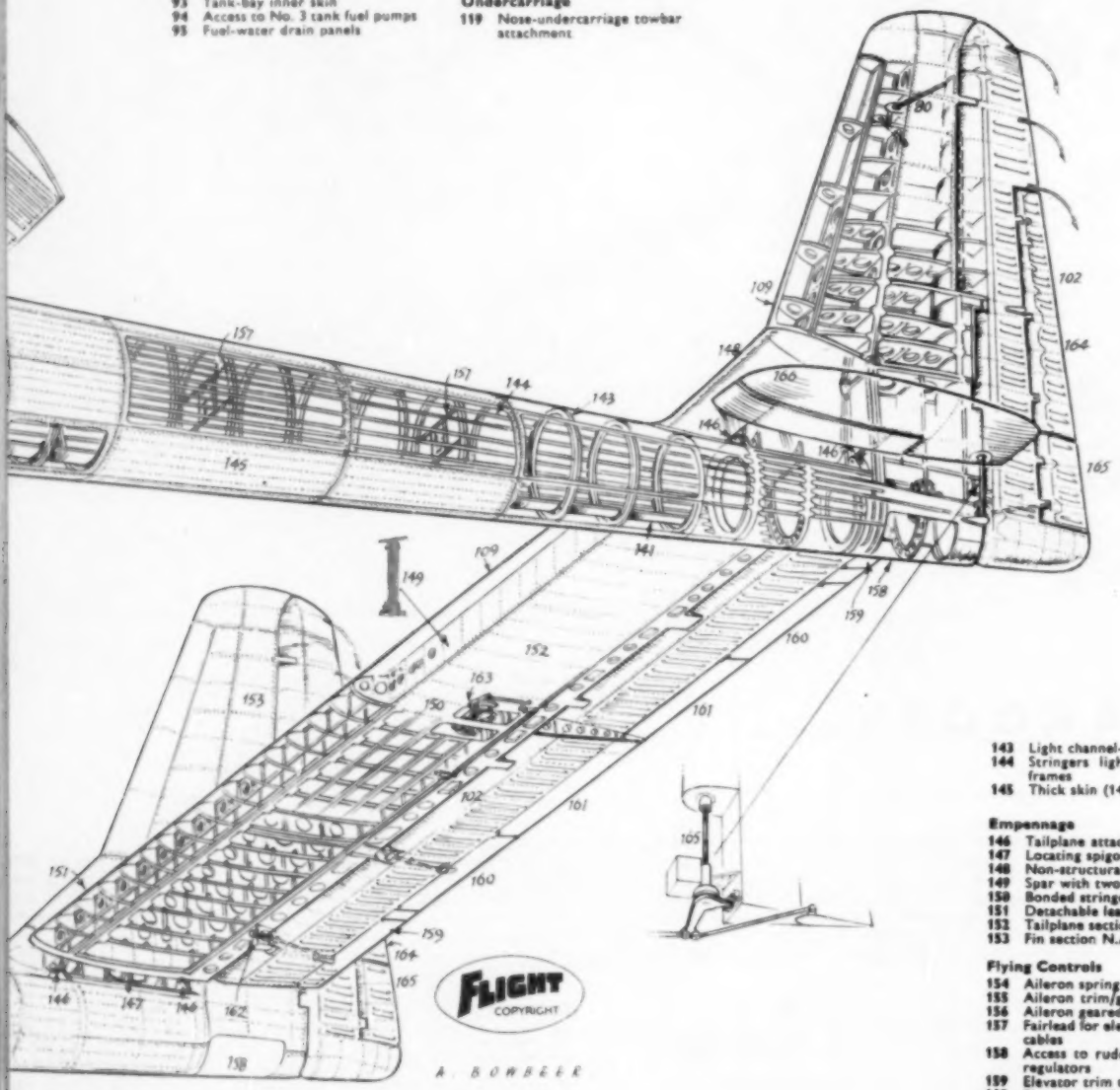
100 Warm-air exhaust
109 Spraymat electric de-icing on empennage

Powerplants

110 Airflow through oil cooler
111 Engine air intake
112 Accessory gearbox above jet-pipe
113 Inter-zone firewall
114 Firewall (marking rear limit of Viscount-type power package)
115 Fire access panels
116 Cooling air to Zones 1 and 2
117 Cooling air to generator
118 Electrically heated spinner and intake

Undercarriage

119 Nose-undercarriage towbar attachment



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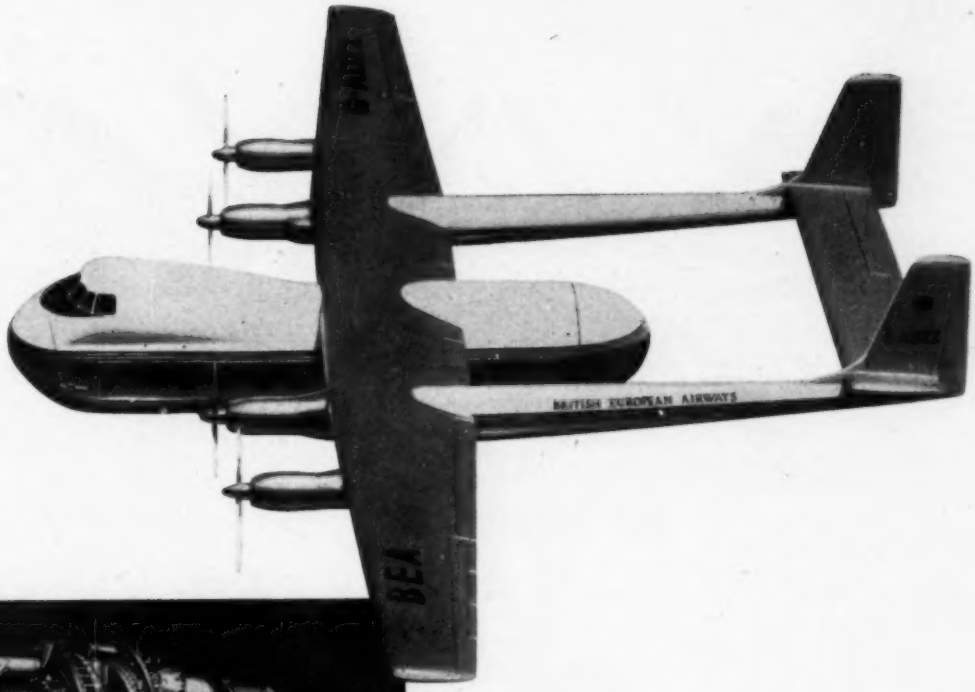

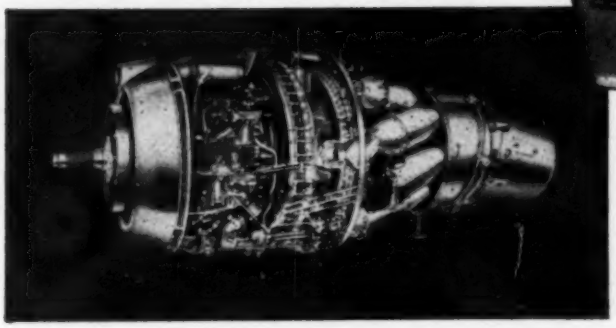

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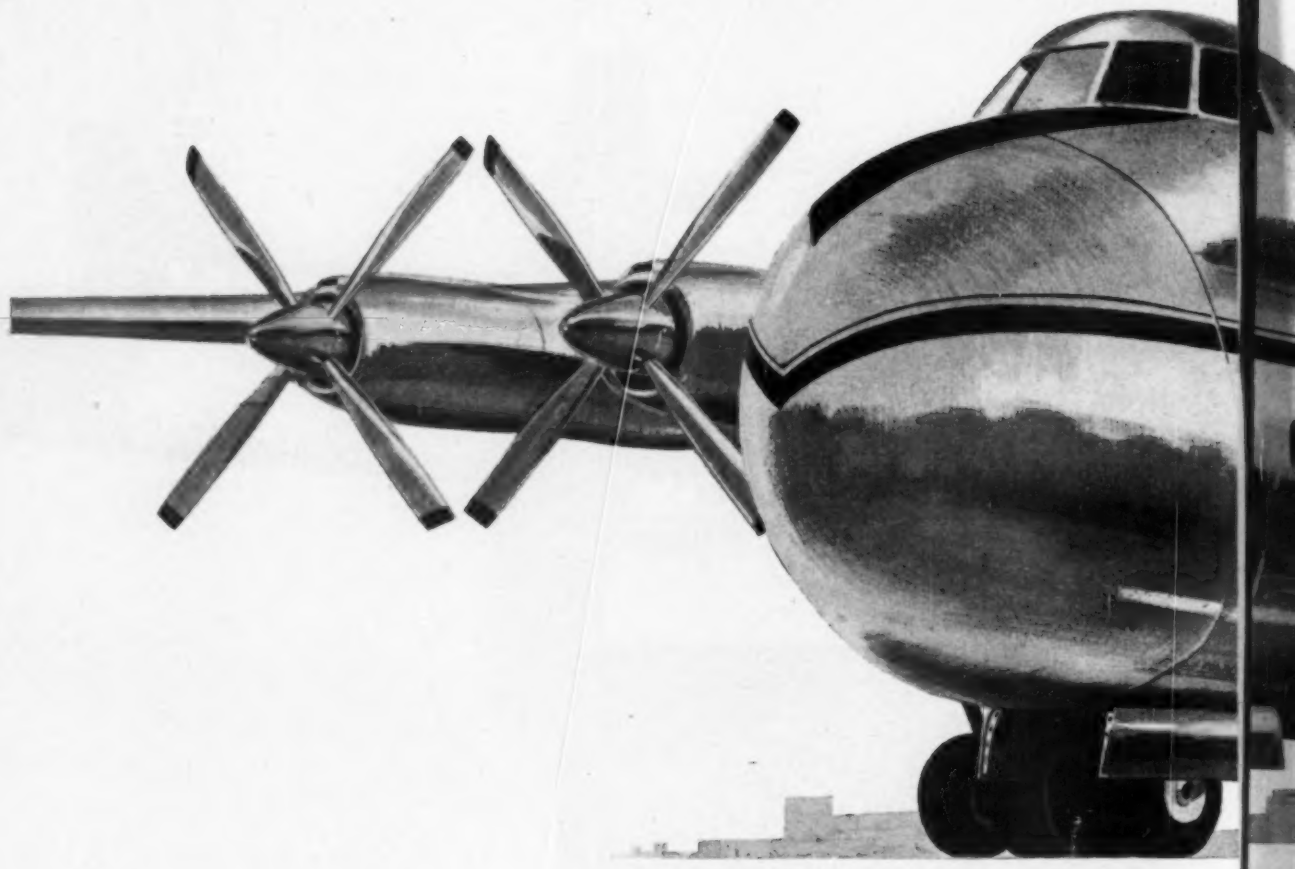
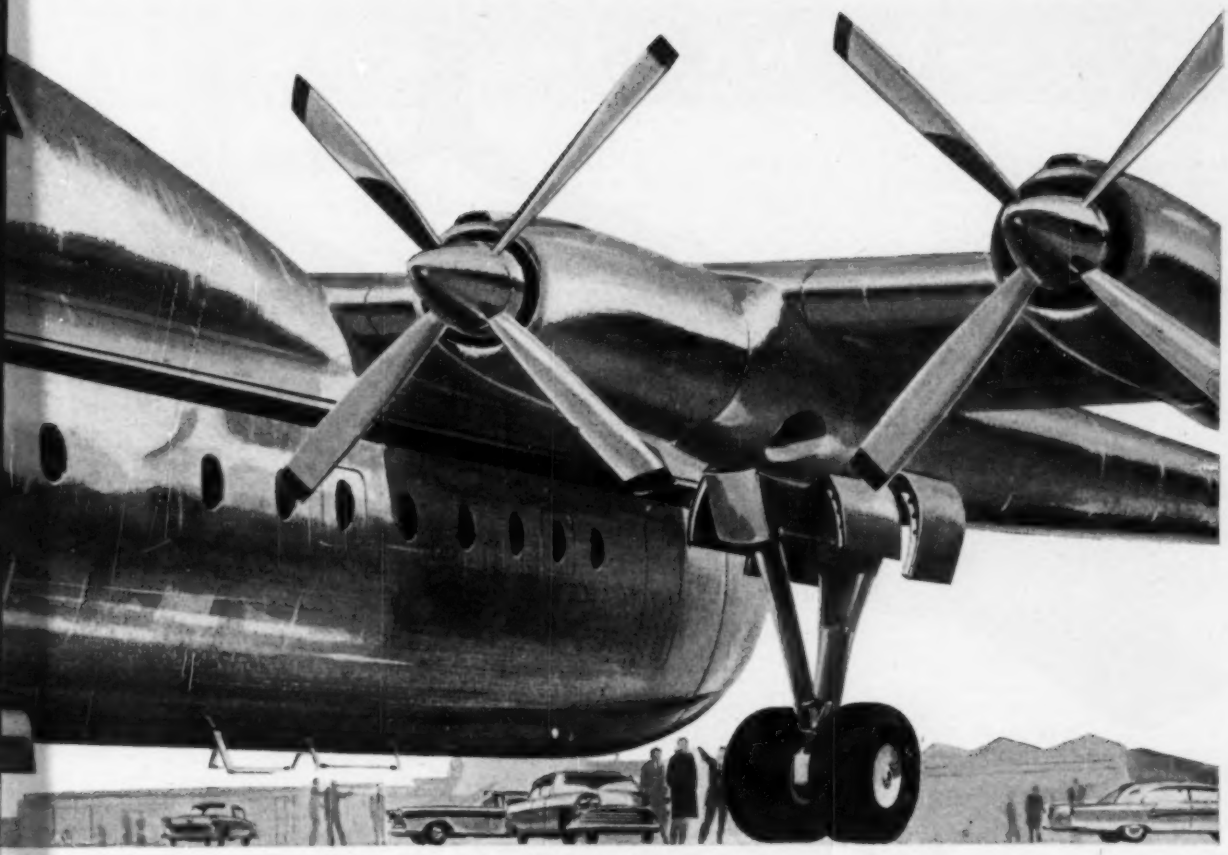


Meet the New ARGOSY!

WORLD'S FIRST TURBOPROP FREIGHTERCOACH TAKES ON A GREAT NAME IN CIVIL AVIATION

SIR W.G. ARMSTRONG WHITWORTH AIRCRAFT LTD.,
Baginton, Coventry, England · Member of Hawker Siddeley

THE ***Argosy*** ——BRINGS THE COST



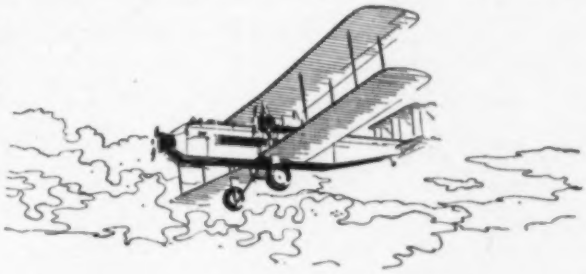
In the story of British aeronautical achievement, some great names stand out: aircraft that made their mark in the skies and helped to further aviation progress.

Such a name is the ARGOSY—the first civil aircraft built by Sir W. G. Armstrong Whitworth Aircraft Ltd., back in 1926. It made history as the first commercial aircraft to pay its way for an airline, and inaugurated Imperial Airways' famous Silver Wing lunch-time service between London and Paris. Economic operations were made possible by its trouble-free maintenance, reliability and capacity.

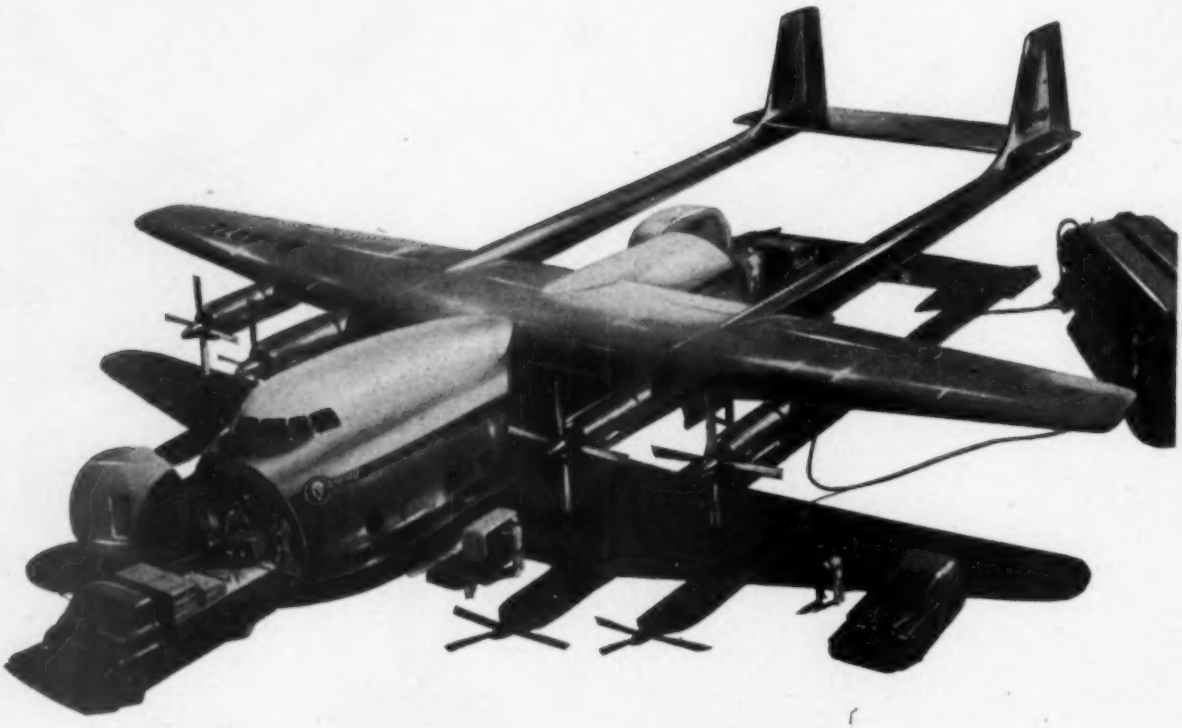
The new turboprop ARGOSY, to make its first flight by the end of the year, is the jet-age successor of its famous namesake. And like the old ARGOSY, the Freightercoach (designated the AW650) will open a new era in air transportation. It is a most versatile aircraft. Not only can it carry up to 80 passengers in pressurized comfort at a speed of 300 miles an hour, it will also open a vast new market in air freight. The modern ARGOSY carries over three times the load of a Dakota at twice the speed and half the cost.

PERFORMANCE:

POWER: 4 Rolls-Royce Darts
AIRCRAFT CRUISING SPEED:
(14,000 r.p.m.) 296 m.p.h.
MAXIMUM PAYLOAD: 27,000 lb.
RANGE WITH 20,000 lb. PAYLOAD:
1,600 st.m.
SIZE OF HOLD:
46 ft. 8 in. (14.23 m.) x 10 ft. (3.05 m.)
floor area 426 sq. ft. (39.6 sq. m.)



OF AIR FREIGHT DOWN TO EARTH



BUILT-IN DEPENDABILITY

In the A.W. Argosy every component part and assembly must measure up to the exacting design standards of the rest of the structure. For this reason the design responsibility for the Argosy's tail unit, its flying control surfaces and passenger doors together with the stress calculations for the huge nose and tail cargo-loading doors, was entrusted to Gloster Aircraft Company Limited. Glosters have nearly 20 years of unbroken experience in the design of high speed jet aircraft—longer than any other Design Organisation in the world.

GLOSTER AIRCRAFT LTD

MEMBER OF THE HAWKER SIDDELEY GROUP

Straight and Level

A U.S. NAVY pilot took off on a gunnery hop in an FJ-4 Fury at an overseas base. As he released the brakes for take-off, the complete instrument panel fell into his lap. So he taxied in, had the panel secured, and took off again.

Coming in for a landing after the flight, the pilot considered his approach to be normal, and flared out over the end of the runway, unfortunately still with his landing gear up. Two aircraft awaiting take-off transmitted warnings by radio, but not until too late did our friend realize that *he* was the boy they were warning. Runway flares weren't used because the system was temporarily out of action.

Meanwhile, the man on wheel-watch duty had noted the wheels-up approach. He turned on the red light and reached for his hand microphone, which he dropped. As he stooped to pick up the mike, his headset fell off. By this time the Fury was crunching up the runway.

As Grampaw Pettibone, doyen of U.S.N. fliers, comments in *Naval Aviation News*: "Son, this just wasn't your day."

● How liable to backfire are dogmatic statements about aviation! So many words uttered by great men are ripe for eating within a year or two. I only hope Mr. Arthur Raymond of Douglas will forgive me for quoting a remark which he made in October 1956:—

"So what can we say about obsolescence when we look at a continually growing [air transport] market which has no surplus of equipment and where used equipment can be sold at sizeable capital gain? . . . There is never a surplus of transport equipment."

He has been proved so wrong; and, ironically, Mr. Raymond's DC-8 has been partly responsible for the way things have turned out.

● Do you know which is the largest single private investment ever made in a new product?

I believe it is the $250 million sunk by Douglas in the DC-8 programme.

● DRIFTING BLIMP IN BUSY AIRLANE

This recent headline in the *Daily Telegraph* raised my hopes that at long last the Government have called in the one individual who could solve the air traffic control problem. But Sir Charles Boost is not in the mood: he has been almost a broken man since he was unable to prevent the formation of the Friends of the Turboprop League.

Anyway, the headline referred to a U.S. Navy blimp which had gone berserk in the busy airway between New York and Miami. Navy fighters were about to shoot it down—what fun!—when it landed gently near Brunswick, Georgia.

● People outside the operating business who want evidence of the world airliner-surplus have only to watch the advertisements for second-hand aircraft. For example, last January Cyprus Airways were offering two DC-3s for the reasonable price of £47,000 each. Each had probably the lowest hours of any airline DC-3 in the world, and they were offered with zero-time powerplants and current Certificates of Airworthiness.

On past form such an offer should have been snapped up. But the aircraft are still unsold, even though the price is now advertised as £30,000.

Learning that Norman Hartnell is designing a new uniform for B.O.A.C. stewardesses, I present this little fashion plate for his attention. Marianne Burt (*left*) and Joan Williams are English, in T.W.A. employ as stewardesses. They gave up their former jobs as professional dancers for the higher calling.

● Airliner paint-schemes, to paraphrase Polonius, oft proclaim the airline. I believe that one of the most revealing outwards signs of an airline's attitude to business is the way it styles its aircraft—particularly its new aircraft. I have often wondered how many more seats B.E.A. would have sold had the Corporation styled its Viscounts, inside and out, more imaginatively.

I suppose B.E.A. consider American-style paint-schemes to be flashy and vulgar. Perhaps they are; Continental certainly went to extremes in their enthusiasm to promote the Viscount 812 (see *Flight*, September 5, page 399). But at least the enthusiasm was evident, and so was the word VISCOUNT, proclaimed in large characters on the fin, as on Capital's and T.C.A.'s Viscounts.

I am sorry to say that B.E.A.'s future new aircraft look like being as plain as ever. The Comet 3B at Farnborough appeared almost wan, as if someone had said at the last moment: "I suppose we ought to put some markings on it."

Come on, B.E.A., use a bit more imagination. There is one aircraft in particular which deserves the Corporation's most aggressive promotion—the Vanguard. And one way in which they can display their enthusiasm for the aircraft which, after all, they inspired is to style it really attractively, inside and out. If necessary, the Corporation should call in consultants, as B.O.A.C. have done for their Comet 4 interiors—with quite outstanding success.

● Do you remember when you could hardly open your paper without reading of some new calamity that had befallen the Hunter? Deliveries were late. On the rare occasions when a Hunter managed to fire its guns it either stopped its engine or did itself a structural mischief. Its air brakes were a bit of a joke; so were its controls. It had no range worth mentioning. Anyway, who would think of buying a subsonic aeroplane—except the R.A.F., of course. And they were stuck with it.

Take a look now.

The R.A.F. adores it (ask Roger Topp and his merry men), and the Navy has bought some, too. Hunters have been exported to, or built by, Denmark, Sweden, Peru, India, Switzerland, Iraq, the Netherlands and Belgium to a total value probably exceeding £150 million. It is estimated that over a thousand have been ordered.

This same reviled aeroplane has been developed into the finest two-seater of its class on the market today; and it has been described by an American authority as the best ground-attack machine in the world (and he should know, having observed the Swiss trials from close range).

Now Hugh Merewether has flown one for over 1,800 miles unrefuelled; which is a long, long way in any man's language—even American.

● And while we're about it, let's have a look at the Sea Hawk. The R.A.F. didn't want it; so it was chopped and changed around to suit the Navy. They bought it, and *they* loved it. And when F.A.A. pilots had a friendly dust-up with swept-winged Americans they found that the 'Hawk had the edge in more ways than one. Then the Netherlands bought some; and now the Germans are taking delivery of a nice fat batch.

What price Sea Hawks now?

● Before B.O.A.C. vanquished those Pan American "first jet" claims, de Havilland took a good-humoured tilt at them. In a Comet news-release they appropriated PanAm's claim "First jet airliner on the Atlantic . . . on the Pacific . . . in Latin America . . . round the world, etc."; then added simply: "First jet airliner."

ROGER BACON

In the heading picture is the Saunders-Roe rocket test site at High Down, near The Needles, Isle of Wight. The safety officer's blockhouse can be seen in the middle distance. The far gantry is not yet completed.

The Black Knight shown at Farnborough after the S.B.A.C. Display, complete with whip and bayonet aerials. These had been removed when the vehicle was on view at High Down.

BLACK KNIGHT

An Inspection and Some Deductions . . . by JAMES HAY STEVENS, A.F.R.Ae.S.

WHATEVER one's personal feelings regarding the coyness which surrounds our first step towards *inner* space, it is certain that official caution has detracted much from the prestige to be gained by the first-shot success of Black Knight.* One would suggest that it was an ill-judged policy to have a display-platform prepared at Farnborough—the reason for which was an open secret to most people at the S.B.A.C. Exhibition—and then to have so little faith in British engineering skill, and to show such fear of "doing a Canaveral" that the exhibit was left covered by a dejected-looking tarpaulin. Since ours is a democracy, any news of a false start would quickly have leaked from the wastes of Woomera; and there seems no sense in hiding a rocket (of which a couple of dozen are being built) before it has "flown" when one-off prototype aeroplanes are revealed.

The veil of Security still thickly surrounds Black Knight—which is probably fair enough, for it is, one supposes, essentially a free-flight test-vehicle representing the D.H. Blue Streak IRBM. So it is a case of looking and asking no questions, for if one is not exactly told lies, one certainly gets no answers. Information about the Saunders-Roe test site at High Down, I.o.W., is rather less Restricted, but even this is limited mainly to concrete facts about the infrastructure.

This preamble is, one feels, necessary in order to explain certain complete misstatements which have been published, as well as to excuse the comparatively elementary nature of the following descriptions—which are perforce strictly limited to the "externally obvious" features of missile and site.

The Project. The £5m Black Knight project is under M.o.S. contract and was devised by the R.A.E. Under the general direction of Dr. G. W. H. Gardner, who was Director-General of Technical Development (Air) at the M.o.S. before he became Director of the R.A.E. in 1955, the project has been the joint responsibility of Mr. D. J. Lyons, Director of the R.A.E. Ballistic Missile Division, and Mr. J. E. P. Dunning, Chief Superintendent of the R.A.E.'s Rocket Propulsion Division, Westcott.

Airframe (if it were not ambiguous in engineering one would be tempted to write "spaceframe") responsibility was delegated to Saunders-Roe and engine manufacture to Armstrong Siddeley Motors. The liquid-rocket motor, one understands, was actually a R.A.E. design, but its construction, development and test-firing were the work of the contractor's rocket division at Ansty under Mr. S. Allen. As far as can be gathered, the airframe design responsibility was completely vested in the Saro team led by Mr. M. J. Brennan and his chief rocket development engineer, Mr. P. L. Leyton.

The history of the Black Knight programme has been one of rapid progress, for it was only conceived late in 1955. The biggest drag upon large rocket projects today is the cost of, and time to build, the infrastructure—to excavate vast pits and deposit thousands of tons of concrete for firing bases in far-away places. When Saro, as a D.H. associate, was approached about the re-entry research rocket programme the old War Office fort near The Needles was immediately considered, both because of its remote location and of the numerous subterranean emplacements already existing. Curiously enough, the public is now allowed nearer The Needles than was the case before the first fort, supplemented in 1895, was built in 1860. Adaptation of the military buildings and use of the sloping cliffside facing out to sea meant a terrific saving in the amount of soil which had to be shifted—in fact, Mr. Brennan says that Lord Palmerston's budget bore half the cost.

The Site. Dates speak clearly: the scheme was approved on April 16, 1956, and the first High Down firing was achieved, with the help of some midnight oil, on April 16, 1957. The work included removal of some 10,000 tons of chalk from the steep slope of a torroidal depression in the downs to seaward of the Allum Bay promontory. This provided space for the foundations of two deeply embedded firing pits, a central surveillance emplacement, a connecting promenade and an approach road. Gravity helped with the economics, for soil could be tipped over the cliff and delivery to the concrete mixers was likewise by tipping, in this case from the crest of the ridge. Under the road are numerous conduits for power supplies, instrument cables and the large cooling water supply. The latter, at the rate of 3,000 gal/min, comes from the public water supply by way of a new reservoir on the top of the down.

One of the principal virtues of the site is that the contours project all the noise out to sea and—so successfully, according to

**All efforts to date, by any nation, have been aimed at inner space; none has stayed entirely outside the effect of atmosphere.*

Mr. Brennan, that even the nearest inhabitants are rarely even aware that a rocket is being fired.

Each firing station consists of a concrete base with a central pit containing a massive welded boiler-plate elbow duct for deflecting the exhaust gases—cooled by evaporation of the cascade of water—toward the sea. On the base is mounted the welded-steel-tube launching cradle, a replica of that at Woomera; it served as a prototype, as it was as much in need of testing as the missile and its motors. Around the cradle is a tall steel framework with a number of access platforms (called decks on the site plan) at seven-foot levels, the whole being enclosed in a corrugated "box" topped by a gantry and lifting tackle. One side of the box opens to admit the rocket, and glass-fibre panels inset in two sides shed some light on the proceedings.

To the base of Black Knight are piped all the services which are needed for an actual launching, while at its head electronic test equipment, including cathode-ray oscilloscopes, is plugged into the multiple-pin sockets of the telemetry and guidance bay. On the occasion of our visit the aerials had been removed.

In the centre of the promenade is the concrete blockhouse, which contains the electric water pumps and a direct-observation room. The latter has an armoured-glass viewing slit and a periscope focused upon the bottom of each firing position. It is also the position of the safety officer, who has a tell-tale console which keeps him informed of the step-by-step progress of a firing, and over-ride controls by which he can cut off the test if a dangerous malfunctioning occurs or appears to be imminent.

Up in the old fort there is the main control room (which, with its console carrying flashing lights, and tone-change electronic sound indicators, reminded one irresistibly of a science-fiction film), the indicator room and the recording room. In the last-named some two hundred channels can be accepted and recorded by magnetic tape, photographed oscilloscope displays and needle traces (a battery of 20-channel Lichtpunk-Linienschreiber) on moving strips.

It was emphasized that once the initiating button has been pressed the firing sequence and the simulated flight are entirely automatic. The programme is set up by putting perforated plates over a battery of master push-switches in a console in the indicator room. The different services are colourfully identified and a number of the pierced masking plates are available, so that those required can be selected on the familiar punched-card index principle. Once the programme has been set up, a locking frame is closed on the console and padlocked. Some of the dials seen in the indicator room show variously that Black Knight's "fuselage" is pressurized with air, that control power is hydraulic, that nitrogen is available for purging, that the fuel is kerosine and that the oxydant is high-test hydrogen peroxide. As a Security precaution, apparently, one console was completely blanked.

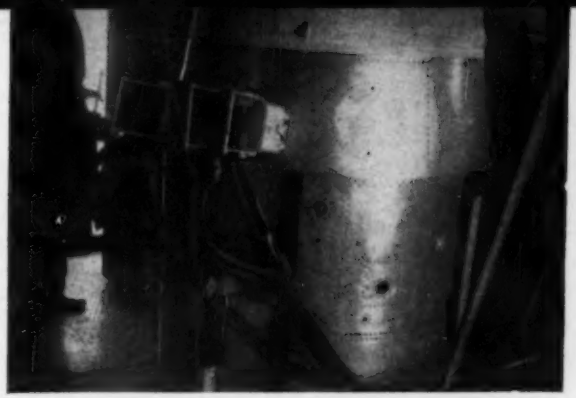
In addition to these rooms there is a battery chamber wherein the tiny high-output 6-volt 9 amp/3 min alkaline cells (André-Yardney system) are prepared and charged. These, together with the red four-minute space marked on the plus-and-minus master-clock dial, might be indicative of the duration of Black Knight.

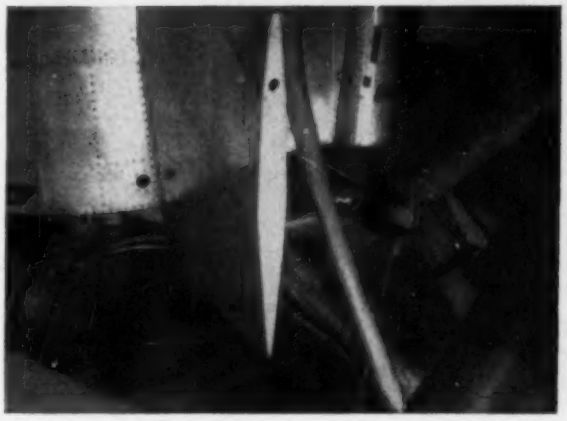
At the High Down site Saro carries out two types of test: "hot" and "cold" firings. Once the rocket motors were proved reliable and the necessary data about their behaviour obtained, the majority of the runs have been "cold," save for the proof firing of each round prior to its shipment to Australia. Details of a cold firing were not divulged, but one would assume that it includes sequenced operation of turbopumps and hydraulics—powered by catalysed H.T.P.—with timed signals fed into the guidance aerials and the recording of the consequent control responses, etc. A hot firing includes everything save the release of the restraining latch on the launcher.

The first, and successful, launch of a Black Knight was made at Woomera on September 7, when the vehicle is said to have reached a height of about 300 miles and been lobbed into a selected target area (of unspecified size) about 60 miles away. The flight plan is an initial vertical climb of several thousand feet, then a sloping powered acceleration until the power cut-off, after which it coasts on a parabolic path through its apogee to a free-fall back to earth. During the whole flight, until disintegration, the multi-channel telemetry operates. Additional information is available from tape records and examination of the remains.

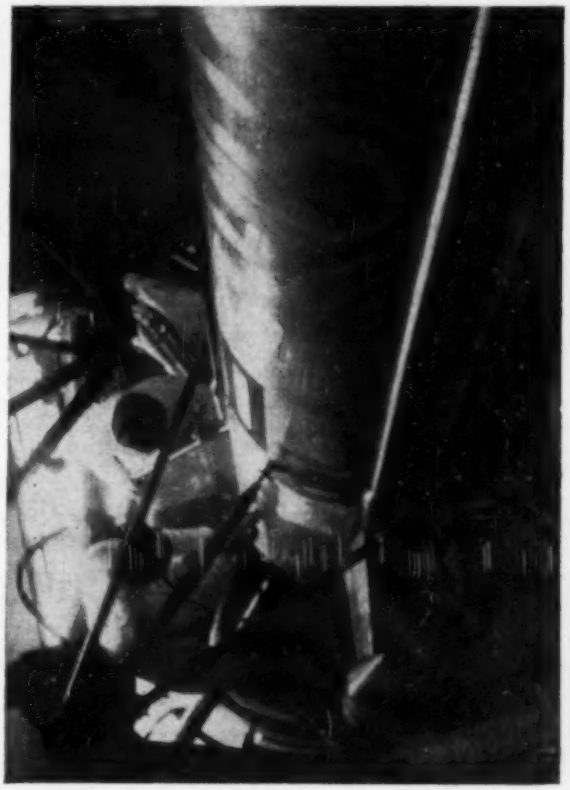
The Vehicle. The Black Knight shown at the R.A.E. and the one fired at Woomera differ somewhat from that available for inspection in the High Down preparation room. The latter was an early airframe used for general static testing, from which the final design had been evolved. The main difference, as can be seen from the photographs, is that its sixteen bowler-hat section longitudinal stiffeners are all external, whereas in the production vehicle only those serving also as fairings for pipe and cable runs are outside the skin. The following description, based on a rather brief inspection of two different rounds and a single showing of an excellent Saro film, is an attempt to give as clear a picture of the vehicle as Security will permit.

The body is officially stated to be about 35ft long and 3ft in diameter, of which some 4ft to 6ft is nose-cone—the Woomera





In the gantry: (Top) Connectors in place in the multi-pin sockets of the electronics bay, and the taped-over dummy nose-cone joint. (Centre) This close-up shows the aerofoil section of the fin and part of the support structure. (Below) The handling crew offers up the stern connector plugs for the benefit of photographers.



BLACK KNIGHT . . .

cone had an included angle of some 30 deg compared with about 20 deg on the one shown at the R.A.E. Both have radiused tips and those on exhibition were palpably dummies to disguise the materials being tried to solve the military problem of re-entry.

Apart from a short tapering lead-in to the cone, the body is cylindrical—and even here there are differences, for the R.A.E. model's cone encompasses this initial taper. About 3ft of the body aft of the nose-cone bulkhead is the electronic bay, then comes the kerosine tank of about 4ft, next the H.T.P. tank section some 17ft high, and lastly the 5ft or so of the engine and control bay; the fins project slightly below the stern-frame.

The structure is typically aeronautical and not unconventional, although the stressing problems must have been peculiar. In a ballistic vehicle every pound left at burn-out counts, for it is the last push of excess thrust over mass which gives altitude and range. The body design resolves itself into an extremely thin-walled tube in compression—the thrust at the base against the weight of the contents. Little has been published on the behaviour of such tubes, but one would expect them to present considerable problems in buckling (several U.S. missiles have broken in half), the difficulty being to stiffen the skin against secondary failure without increasing the weight penalty. It has been noted that the tanks are pressurized, and this "inflation" should give considerable relief (like inflation of a tyre or balloon) for any buckling loads that develop, say, as the vehicle is tilted on its trajectory.

Bowler-hat sections are used for longitudinal stiffening—in the early model an internal channel was used to back-up the main external ones—and both flanges of these strakes are riveted to the skin. This last is extremely thin, of the order of 22 s.w.g., or even 24 s.w.g., light alloy. To it are stitch-welded closely-spaced C-section ring frames. Since the skin has to be put together as a series of butt-welded cylinders, the length of which is limited by the standard metal sheet and the jaw depth of the welding machine, it might be that the intermediate internal stiffeners are intercostal. External examination suggests that there are fewer internal longitudinal stiffeners than on the prototype and they are certainly welded to the skin.

The electronic and engine-bay structures are assembled with mushroom-headed rivets, as are the four rudimentary fixed tail-fins. These last are required to give aerodynamic directional stability during the initial atmospheric phase of the flight, when the vehicle's situation is that of a finger-balanced pencil. The fins have wedge-plate-wedge section supersonic aerofoils with a radiused leading and squared-off trailing edge. The structure consists of conventional flanged-and-pierced spanwise and chordal members with a thin skin. The conically nosed nacelles on two opposing fins are containers for equipment.

The remaining external longitudinals appear to form two fuel-cum-wiring fairings extending from the base of the nose-cone to the motor bay, with four shorter ones for oxydant lines. Four light cables with turnbuckles, visible on the Farnborough vehicle, were no more than temporary attachments tying the nose-cone to the lateral steadying pads.

The motor bay, with its numerous access-holes—open at Farnborough and taped-over at High Down—is noticeably more robustly built than the welded tank section. The Saro film showed why: the whole tail vibrated violently as the motor nozzles were swivelled rapidly to test control responses.

The successful first launching of Black Knight is probably not unconnected with the use of H.T.P., which has none of the freezing problems of liquid oxygen that have certainly caused some of the Cape Canaveral miscarriages arising from jammed valves and stopped pipes. In the absence of an official pronouncement, the fact that Armstrong Siddeley (lately designers of the liquid-oxygen Snarler and Screamer rockets) were responsible for the power unit obscured the fact that Saro was, with de Havilland, the pioneer of H.T.P. in Great Britain. Saro, in fact, first showed H.T.P. tankers and handling equipment at Farnborough three years ago—long before it was possible to say why in any detail.

Four rockets are used—probably because a developed design was available, rather than as a technical desideratum, since such multiplicity naturally increases the risk of a failure. On the other hand, it does obviate the complications of gimballing the nozzles, as all the necessary control moments can be produced by rocking opposing pairs on simple trunnions. They are, in fact, mounted around a central strongpoint thrust-casting, which also incorporates the tie-down ball fitting. Neither the weight nor the thrust of Black Knight has been divulged, but the modestly shrouded nozzles seen at High Down had an external diameter of about nine inches—larger than the Scorpion, smaller than the Spectre.

Only the machined external casing was visible, but it is evident that an efficient cooling system is present to permit both test and flight firings of several minutes' duration. In this connection one would recall that the full specific impulse of H.T.P. and kerosine can be developed (that is to say, the stoichiometric mixture ratio can be used) without reaching temperatures that are prohibitive for present materials. Between the nozzles are four slender metal ducts which are obviously exhausts from the turbo-pumps, which must certainly be driven by catalysed H.T.P. It was mentioned that a pack of ninety silver-plated bronze gauzes is used for catalysis, presumably for the dual purpose of feeding both turbines and combustion chambers.

The Saro film showed the hot end of a motor with no more than a rich glow in the orifice and the first incandescent shock diamond a couple of diameters downstream. The nozzle was first slowly rocked (by its hydraulic power unit) perhaps ±5 deg, then extremely rapidly back-and-forth, causing terrific vibration in the adjacent fin as a result of the rigid fixing of the vehicle.

Preparation. The Woomera equipment includes a wheeled version of the High Down tower, or gantry, so the film of the preparation of a vehicle for static firing must be representative. It takes three men seventeen minutes to get the vehicle off the assembly trolley in the preparation room and to erect it in the gantry.

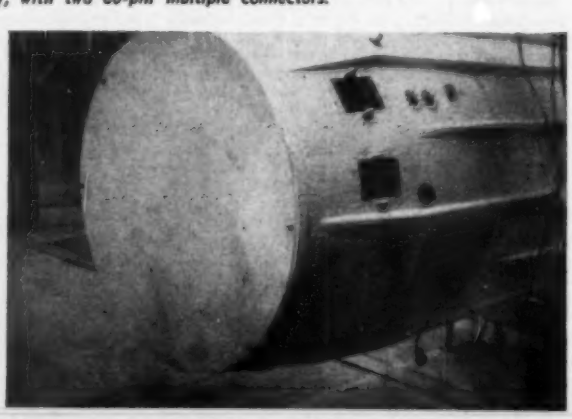
In the preparation room the body is held by bow and stern (or top and bottom) clamping rings with four steel-tube spreader bars. The rings have peripheral tracks so that they can be rotated in rollers on the trolley to turn the missile any way desired. For transport to the gantry the missile is hoisted by the clamping rings on to a very rigid truck that has extendable top rails. When the gantry is reached these rails are slid out to mate with the launcher and the bow is then hoisted to up-end the missile. Once it is vertical the oxydant and fuel are pumped in, the body pressurized and all the various connections made.

The launcher is not a "pad" in the accepted sense, but a sturdy welded-steel cradle or truss about 8ft high, with a walkway half-way up. The Black Knight rests on four fittings attached to lugs on the stern-frame midway between the fins and is steadied by four pads resting against fittings on the forward (top) bulkhead of the engine bay. The ground connections at the stern plug fore-and-aft into sockets in projecting pads on the body and are withdrawn as the missile rises by tension rods attached to the launcher. The multiple-pin connectors at the bow are, in an actual launch, looped from a tall pole, and one imagines that the massive two-handed attachments must contain a throw-clear spring mechanism.

The vehicle is also held down by the axial ball fitting, which is locked to the launcher by a bomb slip while the motors are brought up to full thrust and checked. When the slip is released the missile rises and its mass-balanced and spring-loaded steadies and supports at once throw clear to give it unimpeded passage.

The Future. The present Black Knight is, in effect, a modern V2, smaller but with far greater performance. Practically no definite facts about it have been released, although *Aviation Week* suggests it reached 8,000 m.p.h. in the first launch. Ideas are in mind for using it to launch a solid-propellant rocket similar to the Skylark and even to make it the middle stage of a satellite launcher, using Blue Streak as the first stage. The decision mainly depends, one imagines, upon the contemporary political climate.

Left, rear view of the early vehicle, showing the support points (black fishplates), the fin layout, the four masked nozzles, and the handling-frame clamping ring. Right, the electronics bay, with two 80-pin multiple connectors.



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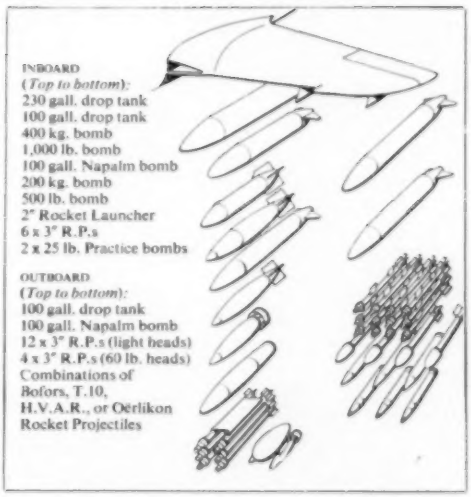

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SERVICE AVIATION

Royal Air Forces and Naval Flying News

Interior of the restored St. Clement Danes, looking towards the High Altar.

"Flight" photograph

THE R.A.F. CHURCH

ST. CLEMENT DANES, the famous Wren church burnt out by enemy action in 1941, has been splendidly restored and is to be re-consecrated by the Bishop of London next Sunday—in the presence of the Queen—as the central church of the R.A.F.

With its cream-and-gold ceiling rising above the dark oak of gallery and pews, this seemly place of worship has put on a gracious new face for its new use. Sir Christopher Wren (whose work is commemorated in the wording "Aedificavit Chr. Wren AD. MDCLXXXII" on the restored Royal coat of arms) would no doubt be flattered and pleased that his original design has been so faithfully followed by the architect, Mr. W. A. S. Lloyd; and the work of all those who have contributed to the building has combined to make it a worthy and beautiful place of worship and remembrance. Its famous one-time parishioner Dr. Samuel Johnson, whose seat in the gallery is marked by a brass plate, might well feel at home in the new St. Clement Danes: for the Grinling Gibbons pulpit (or said to be his) was preserved from the 1941 holocaust; and so were six gay cherubs, credited to the same carver, who now sit angelically above the reredos.

All else within the church, however, is new; and nearly all of it, with the exception of the Church of England diocesan shields set in the ceiling, pertains to the R.A.F. and Commonwealth and Allied air forces.

Inlaid in the floor below the organ gallery, a large R.A.F. crest forms a centrepiece for surrounding crests of the eight Commonwealth air forces; around the walls are ten glass-fronted shrines of remembrance that will contain ten volumes in which are being inscribed 125,000 names of R.A.F. personnel and those of other nationalities who served under R.A.F. command throughout the world; set into the Portland stone floor of the nave are 735 badges of R.A.F. units all over the world; those of the R.A.F. Commands are incorporated in the lighting sconces attached to the piers below the gallery; and beneath the west end of this gallery is a U.S.A.F. shrine which is to contain a book of remembrance recording the names of 16,000 members of the U.S.A.F. who died in the last war. The organ above it is a gift from the Third U.S.A.F.; the lectern has been given by the R.A.A.F.; and in the crypt—which is to be used for the first time as a place of worship—the font has been given by the Royal Norwegian Air Force and the altar and sanctuary by the Royal Netherlands Air Force.

The altar and chancel of the new St. Clement Danes—to the building of which every R.A.F. unit in the world has contributed—have as their centrepiece a painting on wood (by Ruskin Spear, R.A.) of the Annunciation, and above it rise stained-glass windows—the work of Carl Edwards—depicting the Nativity, the Crucifixion and the Resurrection. All the other windows in the church are plain glass, letting in the light generously; and 11 bells in James Gibbs' fine steeple—ten of them re-cast from the metal of the old bells, with one newcomer added—will once again peal out the "oranges and lemons" tune which is so beloved a part of the history and traditions of St. Clement Danes.

Carrier-Aid Awards

INDICATIONS of the valuable effects of putting the angled deck, the mirror sight and the steam catapult into service with the United States Navy were given in London on October 3 when, as briefly recorded last week, awards were made to the British inventors of these aids by the U.S. Ambassador on behalf of the President of the United States.

For "exceptionally meritorious conduct in the performance of outstanding services in proposing and fostering the development of the angled-deck principle," Rear Admiral D. R. F. Cambell, D.S.C., received the Legion of Merit (Degree of Officer) and Mr. Lewis Boddington, C.B.E., received the Medal of Freedom (Degree of Bronze Palm). "Adopted by the U.S. Navy in 1953," the citations read, "the angled deck has proved so successful that it has been installed as a standard configuration on all first-line carrier vessels. With the angled deck used in conjunction with the optical glide-path indicator system the landing accident rate has been reduced by about two-thirds." Through their outstanding resourcefulness and ingenuity, these men had been directly instrumental in effecting substantial savings in lives and money.

Cdr. H. C. N. Goodhart was awarded the Legion of Merit (Degree of Legionnaire) and Mr. Dennis Lean the Medal of Freedom (Degree of Bronze Palm) for "exceptionally meritorious conduct in the performance of outstanding services in the invention of the optical glide-path indicator system." Adopted by the United States Navy in 1955, the citation continued, "the optical glide-path indicator system proved so successful that it eventually was incorporated on all angled-deck aircraft carriers and has been installed or is planned for installation at all major naval air stations. Using this system pilots have been qualified for landing in one-fourth of the time originally required when the landing signal officer was employed." The two men had been "directly instrumental in effecting substantial savings in terms of life, time and money."

Mr. C. C. Mitchell, O.B.E., received the Medal of Freedom (Degree of Bronze Palm) for "exceptionally meritorious conduct in the performance of outstanding services in the invention and development of the steam catapult. . . . Adopted by the U.S. Navy in 1952, the steam catapult system has become standard equipment on all first-line aircraft carriers. By accepting this system instead of continuing the development of the hydraulic catapult, the Navy has saved an estimated three years of time and comparable savings in cost. In addition the steam catapult makes possible the operation of high take-off speed and heavy aircraft from practically sized carriers. Through his outstanding resourcefulness and ingenuity Mr. Mitchell has been directly instrumental in effecting considerable savings and improved carrier operations."

On the occasion of the presentation of the five awards, it was stated that 17 attack aircraft carriers of the United States Navy are now equipped with both angled deck and mirror landing system, and 13 of these are equipped with the steam catapult. According to figures disclosed last year the use of the angled deck plus mirror sight had reduced the U.S.N. carrier landing accident rate from 30 to 8 per 10,000 touch-downs, a saving of about 300 accidents and fifty million dollars per year.

Fighter Command's New S.A.S.O.

THE Air Ministry has announced the appointment of A.V-M. R. B. Lees, C.B., C.B.E., D.F.C., as Senior Air Staff Officer, Fighter Command. He succeeded A. V-M. D. R. Evans, C.B., C.B.E., D.F.C., with effect from October 10.

A. V-M. Lees has been A.C.A.S. (Ops.) at the Air Ministry since September 1955, and for three years before that date was A.O.C. 83 Group, 2nd T.A.F. Earlier, for almost the same period, he commanded the Metropolitan Sector of Fighter Command. Born in New South Wales, he joined the R.A.A.F. in 1930 and transferred to the R.A.F. in 1931. His record in the war—at the outset of which he commanded No. 72 Sqn., whose Spitfires helped to cover the Dunkirk evacuation—was a distinguished one.

When, recently, the R.A.F. began to take delivery of Hunter T.7s, A. V-M. Lees was the first Service pilot to convert through this type to operational marks.

F.A.A. Reunion Postponed

TO have been held in London on December 1, the Fleet Air Arm Reunion has been postponed until a date to be announced later. The reason is that aircraft carriers will be absent from home waters, and with them most of their aircrews.

A good ten-cents-worth was had recently by visitors to the observation deck overlooking the arrivals-area at New York International Airport. Side-by-side were the Comet 4 and the Boeing 707, soon to be a daily sight. An up-to-date note on the implications for these aircraft of New York's jet-noise restrictions appears on this page.

CIVIL AVIATION

Signs of the Times

TECHNICAL teams from S.A.S. and Swissair were recently touring California, and rumours from San Diego suggested that Convair were soon to find their first European customer for the 880. On October 6 (as we briefly reported last week), a firm order for five aircraft, valued at $18m, was announced by Swissair.

On the same day a four-year technical agreement was signed in Zurich between Swissair and S.A.S. Two of Swissair's five 880s will be leased to S.A.S., while four S.A.S. Caravelles will be leased to Swissair. The Scandinavian carrier has taken up an earlier option on four Caravelles, bringing the total order to 16, of which 12 will be retained for S.A.S. operations.

Addition of five fuel-cells in the centre-section of the 880 wing will increase the capacity of this intercontinental version to 11,550 Imp gal, allowing the range with full reserves to be increased to 3,400 statute miles. Take-off weight, at 203,400 lb, will be 24,900 lb above that for the domestic version. The aircraft will be fitted with 85 seats—30 first-class and 55 economy-class—and will be delivered late in 1960. As with the 880s, the take-off weight of the Caravelles has been increased and at 100,000 lb will permit a full-payload range of about 1,450 miles.

Both airlines will employ Caravelles in Europe and the Middle East, and 880s on routes to South America and the Far East. The Convairs will also be used by S.A.S. to South Africa and by Swissair to certain points in the Middle East.

This technical agreement allows for a rationalized engineering programme between the two airlines. Swissair will overhaul all five Convairs, while S.A.S. will overhaul the Caravelles and the DC-8s (seven for S.A.S. and three for Swissair). All the aircraft in each of these three fleets will be fully standardized and readily interchangeable.

While jet order-books were being extended in Europe, in North America the cancellations forecast in Prof. Cherington's Report were coming to light: National's firm order for six DC-8s has been cut back to three; Delta have reduced their DC-8 order from eight to six; and the reported Capital order for 15 Convair 880s (nine firm) was revealed as being premature.

In Britain last week a report appeared to the effect that B.O.A.C. were to cancel their Boeing 707s and order Comets in their stead. The Corporation subsequently denied any such intention.

KEEPING THE PEACE AT NEW YORK

LAST week *Flight* visited the Port of New York Authority to discuss the implications of jet operations in and out of New York International Airport. The P.N.Y.A. had just published* in the form of two hefty documents (weighing more than 2 lb apiece) the results of its $400,000 jet-noise programme.

Before commenting on these findings, which *Flight* will summarize at a later date, it is as well to clarify exactly what B.O.A.C. and PanAm can and cannot do at New York.

Identical operating restrictions have been imposed on the Comet 4 and the Boeing 707. Briefly, it is mandatory, when operating conditions permit, for these jets to take off over water, i.e., southwards over Jamaica Bay. The mandatory preferential runway is 25. The length of this runway is 8,200ft; an extension to 10,000ft will be completed by April 1959. When cross-winds exceed 20 kt, Runway 22 (8,000ft) can be used, provided pilots make a right turn early enough to avoid flying over communities.

When—and only when—winds vitiate use of these runways, three other choices are available—but with climb, power-cutback and waking-hours limitations. These choices are:—

(1) Taking off from 13R, i.e., using the airport's longest, 9,500ft, runway (11,000ft by December 31), pilots have to make a 15 deg bank to the right; they must not fly over communities at less than 1,200ft; they will take off at specified power and flap-settings (e.g., 8,000 r.p.m. and 20 deg for the Comet 4); they will maintain V_2+15 kt until over the communities, at which point they must throttle back (to 7,350 r.p.m. for the Comet 4); and they will take off only during waking hours.

(2) Similar rules will apply to take-offs from the same runway in the 31L direction, except that there is no right-turn requirement.

(3) Similar rules will apply to take-offs from Runway 07.

No take-offs from any other runway will be made.

The P.N.Y.A. reckon that, by these rules, about a half of all jet take-offs will be made over water. The other half will result in "perceived noise decibels"—a new sound measurement which recognizes human reaction—which do not exceed piston "P.N.D.s."

Three questions arise: (a) Why are the P.N.Y.A. so noise-conscious? (b) will other airports model their jet-noise rules on the above? (c) how will these rules affect the Comet 4 and the 707 commercially? The answers appear to be as follows:—

(a) The P.N.Y.A. have had a noise problem for seven years. The legal battle fought so long with hostile communities long ago caused the Port Authority seriously to doubt whether New York International could be kept open when jet operations began.

(b) Though the P.N.Y.A.'s rules deal with New York's particularly extreme case, they may be adopted and adapted by the owners of other world airports which are vulnerable to public opinion. In particular, it seems likely that the "1,200ft rule" (height over houses) will come to be standardized by many authorities.

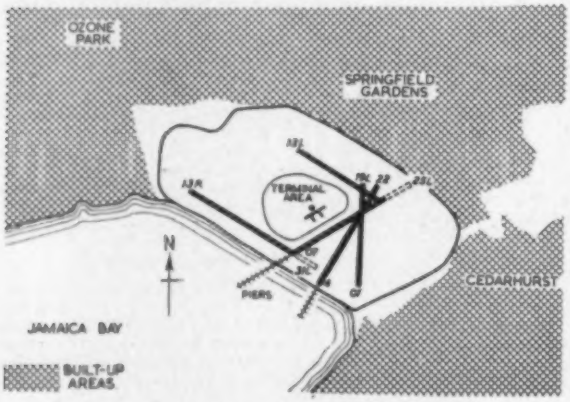
(c) All New York's jet runways are long enough, and the Comet 4's take-off is good enough, for the commercial capabilities of this aircraft not to be penalized. However, the 707-120 will be penalized for transatlantic operations when using 25 and 22, because of C.A.A. field-length requirements (though penalties will be eased when 25 is lengthened next April); and it will be penalized on 13R/31L and on 07 by the climb rules—though again these penalties will be eased when 13R/31L is lengthened.

PanAm have implied that the P.N.Y.A.'s rules discriminate against the 707. The airline recently took Gen. Quesada (formerly the President's civil aviation adviser and soon to be head of the new Federal Aviation Agency) for a ride in the 707. The New York Press was on board, and the following day's papers quoted the General as saying that P.N.Y.A.'s noise restrictions were "very unfortunate." So much did the Port Authority resent this statement that its chairman, Mr. Donald V. Lowe, immediately sent a strongly worded telegram to the President saying, in effect, that it had no intention of changing its policy.

But how long can the P.N.Y.A. hold out before the rising tide of jets? Never before has an airport laid down the law about operating techniques, except in matters of safety. But we have the impression that there will be no climbing down: the residents of New York do not like jets, and they may one day prove that the law is on their side. If they do, New York will be closed.

The P.N.Y.A., which has already spent £60m equipping New York for the jet age, and which knows the value of airports to the community, does not want this to happen. Someone ought to tell the airlines that the P.N.Y.A. is really on their side.

*"*Studies of Noise Characteristics of the Boeing 707-120 Jet Airliner and of Large Conventional Propeller-Driven Airliners." Similar publication for the Comet 4. Prepared by Bolt, Beranek and Newman; published by the Port of New York Authority, New York 11.*



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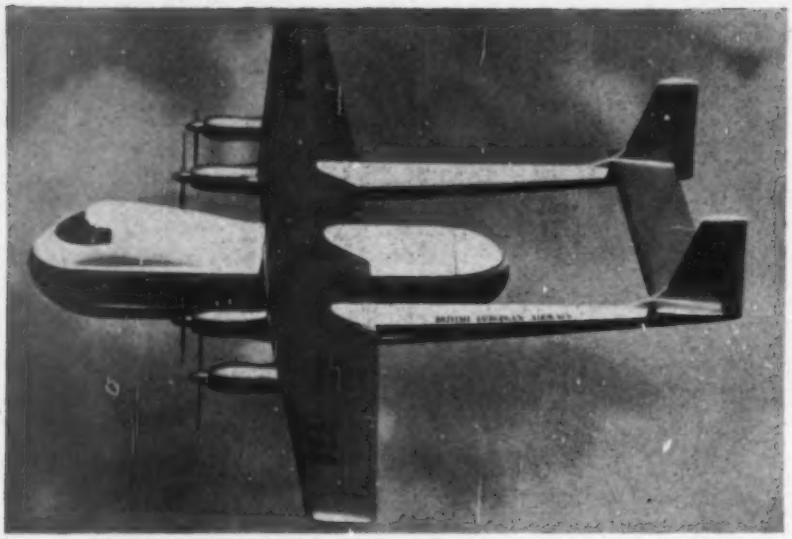

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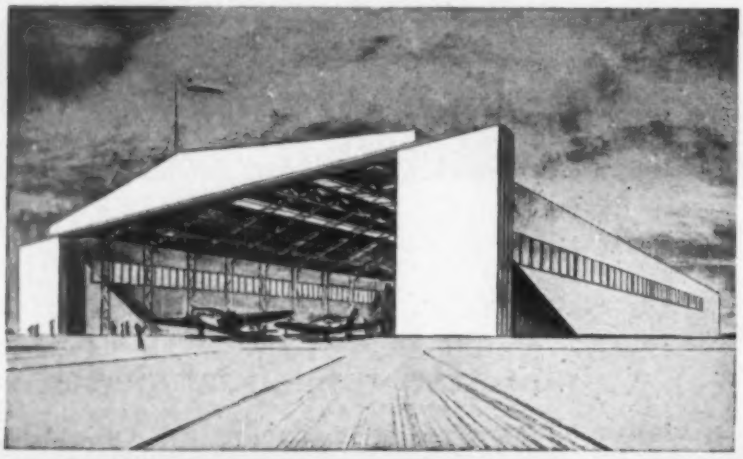

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The first of Lufthansa's nine Viscount 814s was delivered to Hamburg on October 6; the remainder will follow within the next five months. B.E.A. are introducing Viscount 800s on their services to Germany on November 1.

CIVIL AVIATION

THE ELECTRA'S GRAND TOUR

HAVING "flown for the professor" to considerable effect and been awarded its C.A.A. graduation certificate (the examination marks were recorded in *Flight*, September 5) Lockheed's new Electra is sampling for the first time the delights of overseas travel. As seen in the photograph below, declaration that this is the Electra's world première is boldly emblazoned on the fin. As already reported, the aircraft is making its way to Delhi where it will be demonstrated during the I.A.T.A. Conference. It is to visit London for the first time on November 17 and will be demonstrated from Gatwick Airport on that day.

Lockheed have now completed a post-certification analysis of the Electra's performance. Some of the conclusions, which are listed below, may appear to show a surprisingly wide margin over predicted calculations, but they serve to underline Lockheed's carefully conservative estimates of performance before certification was achieved.

All performance guarantees, according to J. B. Wassall, California Division director of engineering, have been made or bettered without the use of tolerances. C.A.A. runway length distances are 770ft shorter for take-off and 650ft shorter for landing (I.S.A. sea level) than originally predicted. Two- and three-engine *en route* altitude capabilities were improved by an average of 2,400ft. Maximum usable fuel capacity is 146 U.S. gal greater than the specification and the refuelling rate has been demonstrated at 420 gal/min, 20 gal/min more than design rate. Also, the manufacturer's empty weight is averaging 386 lb per aeroplane less than that guaranteed.

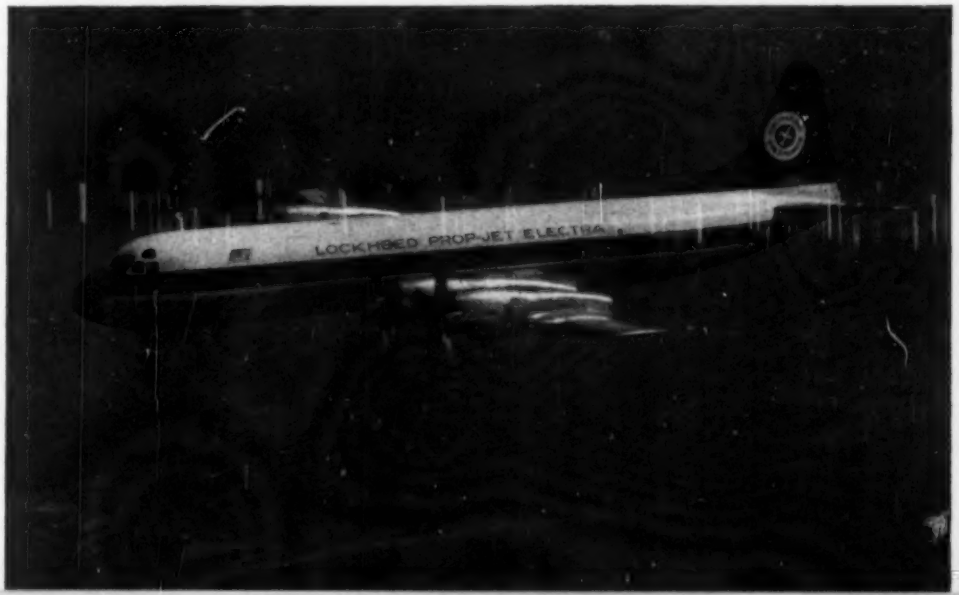
Electra sub-assembly is now going ahead at the rate of parts for 10½ aircraft per month, a final-assembly figure that should be achieved early in the new year. On the line now are 20 aircraft for Eastern and seven for American Airlines. The latter company is now making acceptance trials for its first aircraft.

COLOUR CONSCIOUSNESS

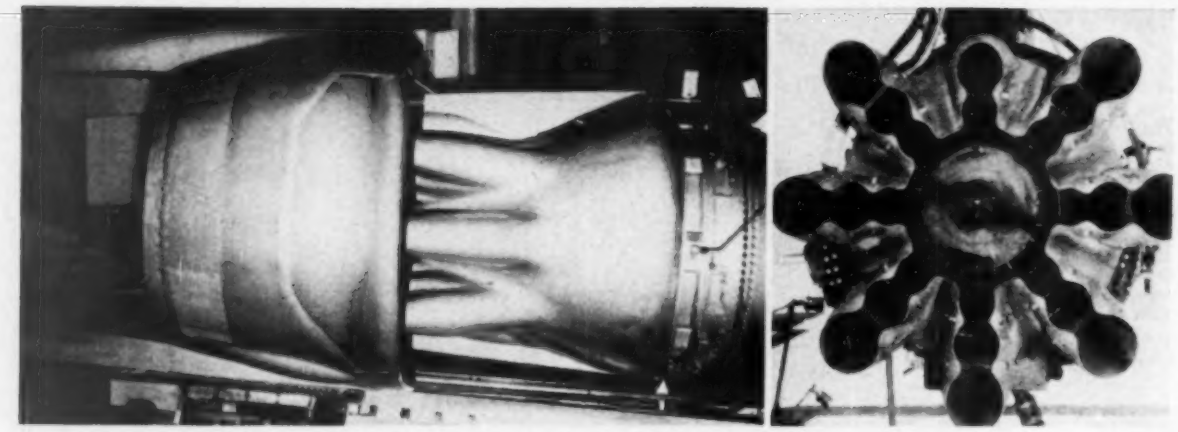
THE October issue of *Design*, a monthly publication of the Council of Industrial Design, contains two informative articles on aircraft interiors. One deals with B.O.A.C. and discusses the Corporation's new policy towards interior design. Credit is given particularly to Mr. Alec Jones, B.O.A.C. advertising manager, for realizing that "something better was needed than the drab interiors that have existed until now." From a list of designers submitted by the Council, the Corporation selected Gaby Schreiber and Associates. Mrs. Schreiber then sought "to break up the feeling of monotony" by conceiving the design scheme "as a quiet background against which the passengers' clothing will contribute the main patches of colour."

The Comet 4 fuselage that had been used for water-tank tests was converted into a full-size mock-up, allowing Mrs. Schreiber to experiment with various schemes. This led to B.O.A.C.'s traditional interior in grey and dark blue being replaced by a "modest sparkle" of corn and pale blue linen head-rest covers, oatmeal and pale-blue seat coverings, stone and turquoise chair arms, brown and white check curtains and subtly varied cushions, all set against a background of green-blue carpet and oyster ceiling. (This colour scheme is also being introduced to the Corporation's 707, DC-7C and Britannia fleets.) Mrs. Schreiber's ideas are not limited to the general colour pattern but cover the wide range of items—rugs, blankets, magazine covers, racks, notices—that contribute to the overall visual effect.

The other article seizes on a problem that is illustrated by B.O.A.C.'s Comets: Instead of considering an aircraft interior as an integrated whole, the manufacturers have allowed the techniques of industrial design to be used only for devising a colour scheme. The results of this are seen in the toilet installed in the Comet ("lacks the overall appearance of simplicity, the clean lines, the sense of style, that such an interior requires"). Examples are



Lockheed are jubilant at the way that the Electra — seen here just before setting off on its world tour— has exceeded its guaranteed performance. Results of a post-certification analysis are given in the news item above.



Two views of the device developed by Douglas to suppress the sound and reverse the thrust of the DC-8. The corrugated exhaust nozzle is combined with a cylinder which extends beyond the nozzle during take-off. This "ejector" is claimed to reduce the sound level by 3-4 decibels and increase the thrust sufficient to offset the loss caused by the nozzle. The indentation near the forward lip of the ejector is one of the two doors which close to form a thrust brake. Noise level with the ejector ring and nozzle combined is said to be reduced by 9-12 decibels.

CIVIL AVIATION . . .

then given of cases where a more satisfactory solution to the problem has been found. The Electra designs produced for Lockheed by Mr. Henry Dreyfuss and Dr. Janet Traveil, and the Viscount scheme devised by Charles Butler Associates are quoted as good examples of "the type of approach we feel is essential if British aircraft are to compete successfully in home and foreign markets."

WANTED: A TUPPENNY FARE

NORTH ATLANTIC airlines have for some years been crowing over the steady diversion of traffic from sea to air. Shipping companies have as yet been unable to match the steady fare-cuts introduced by the airlines, but recent reports from Tokyo tell of an event that might turn the tide in favour of ocean transport. Sasebo Industries are alleged to have agreed to construct two 90,000-ton liners for Mr. Hyman Cantor at a total cost of $140m (£50m). These craft are expected to ply the Atlantic at a one-way passenger fare of only $50 (£18). Assuming a 60 per cent load-factor, airlines will not be able to compete with such low-cost transportation until airliners can operate at a total cost of twopence per seat-mile.

NAUGHTY AIRLINES—1

OF I.A.T.A.'s 77 active member-airlines, no fewer than 33 have been fined for breaches of tariff agreements. Penalties ranging from totals of £70 up to £37,000 per airline have contributed some £236,000 to the I.A.T.A.'s revenue since the Association's formation soon after World War II. These unofficial figures are quoted in *American Aviation*, which says that the cost of enforcement by I.A.T.A. is about £71,000 a year—about a fifth of the annual budget.

The machinery used for resisting non-compliance with the airlines' agreement is the Breaches Commission, a three-man court appointed by the director-general to hear complaints and to assess penalties against offenders. It was originally thought that agreements would be self-enforcing and that if one carrier overstepped the mark the spur of competition would automatically result in protests from others. In practice there has been considerable reluctance to place direct complaints, and most cases heard by the Breaches Commission are brought by I.A.T.A.'s own enforcement officials, nearly always as the result of information supplied to them by a competing airline. I.A.T.A.'s chief enforcement officer is Rudolph Feick, and he is supported by a professional staff of nine others.

Fines can be very stiff; it is believed that, earlier this year, over-liberal interpretation of what constitutes an economy-class sandwich cost at least one airline £9,000; and penalties for failure to observe the appropriate rates of exchange (giving the passengers an effective discount since, *American Aviation* reports, there has never been a case where a carrier has been accused of overcharging a customer) range from £1,800 to £7,000. It is on this account that Panair do Brasil heads the list of the heaviest fines imposed. It is reported that the airline was fined £1,800 in each of 13 violations of the exchange-rate agreement, bringing its total outgoings in penalties to £37,000—an appreciable item in the airline's revenue-expense balance. The American journal states that B.O.A.C. have been fined a total of £3,800 and B.E.A. £640 by I.A.T.A.

Other common offences for which a Breaches Commission requires explanation from the airlines are failure to collect excess-baggage charges; tardiness of agents in remitting money for tickets sold; granting of discounts to over-age "students," or free seats to those who are ineligible; over-generous treatment of travel agents; and violations of the complex agreements covering cargo tariffs.

Airlines asked to appear before a Breaches Commission are represented by counsel and hearings generally last three days. Subsequently two or three more days are occupied in decisions on the cases and the imposition of fines or reprimands. Although all member-airlines have signified their assent to the agreements formed within I.A.T.A., appeals based upon a "liberal interpretation" of new evidence are quite frequent. Sir William Hildred, I.A.T.A.'s director-general, said recently: "In the majority of applications the Executive Committee could find no justification for reconsideration."

NAUGHTY AIRLINES—2

AS if self-criticism was not enough, the airlines are finding their industry the object of considerable reprimand from outside bodies. The recent reports of the I.C.A.O. secretariat and of Prof. Cherington take no steps to conceal misgivings over the jet procurement programme. To these reports are now added some accusations levelled at the major American carriers by Mr. Clarence N. Sayen, president of the Air Line Pilots Association:—

"It appears to us that these same few airlines are not representative of American aviation, but are the ones who have blundered into the jet age without adequate advance planning, producing resultant economic and industrial chaos from which they expect the government or their employees to bail them out . . .

"These are the same few air carriers who have rushed headlong into the jet age, trying to steal a competitive advantage with little regard for the safety of the travelling public, the security of their employees, or the public interest in general. They have purchased jet aeroplanes with money they don't have, to haul passengers which they don't have, out of inadequate airports and with an inadequate air traffic control system.

"They have made little or no preparation to handle the tremendous employee dislocations and retraining necessary, or to establish rates of compensation, rules, or working conditions for their personnel, or otherwise provide for the interest of their employees or the public."

DART HERALD ACCIDENT REPORT

A SPECIAL issue of the Dart Herald progress report, recently published, is devoted to an account of the accident that befell G-AODE on August 30. The cause has been traced and the report lists the measures that are being taken to prevent a recurrence.

The sequence of events has already been made known, but for the record it is worth quoting the official account, which is headed *Major Engine Failure*:—

"At 6,000ft S/L. H. G. Hazelden heard a loud bang from the starboard engine, which immediately caught fire. He noticed the r.p.m. decreasing rapidly . . . and took the necessary action to close the high and low pressure fuel cocks and feather the propeller. The fire-extinguisher had no apparent effect so he throttled the port engine and descended at 150 to 160 kt with the intention of crashing in the first available space.

"In a very short time the aircraft began pitching, and although the pilot felt that a major break-up was imminent he was still able to control

it with the elevator. Some gentle rolling from side to side also occurred, and as the ailerons were beginning to jam he had to use considerable force to overcome it.

"At about 1,500ft there was a much more violent roll, which required full port aileron to correct. This was the point at which the starboard engine and nacelle dropped away from the aircraft, but within a few seconds the machine righted itself although the pitching was worse.

"As S/L. Hazelden approached the field he had chosen he noticed that it had high tension cables running across it. There was insufficient space beyond the cables before the trees at the far end, so he forced the aircraft on to the ground at about 130 kt and slid under the cables.

"The initial deceleration was very mild but the aircraft . . . struck a large tree stump which tore a hole in the starboard side of the fuselage just behind the cockpit. All nine occupants of the aircraft escaped unhurt through this hole. Only four to five minutes had elapsed from the time that the fire began to the final touch-down."

The report goes on to say that Rolls-Royce have inspected the Dart engine concerned and have concluded that failure was initially due to the auxiliary-gearbox breather layshaft fracturing in the undercut between the splines and the threaded portion, interrupting the flow of oil to the turbine bearings. The bearings failed and allowed the high-pressure turbine disc to move rearwards, fouling the interstage seals circumferentially. The resultant grooving and overheating of the turbine disc caused it to fail.

Pieces of the turbine-disc rim severed the fuel pipe and an engine mounting strut and, in the few seconds which elapsed before the fuel cock switches were operated by the pilot, several gallons of fuel (sufficient to cause an uncontrollable fire) flooded the engine bay. The fire-extinguisher operated.

The accumulation of fuel poured out of the holes made in the nacelle by the turbine disc and flowed back along the outside before entering the undercarriage door gaps. The fire continued to burn inside the wheel well.

In falling away, the nacelle pulled the fuel pipes from the wing tanks and allowed a free flow of fuel to maintain the fire under the wing. The flames reached back to the starboard tailplane, half of which was burned off and fell away 200 yards before touch-down.

The fact that the wing strength was maintained, in spite of what must have been considerable damage caused to the structure by the intense fire, is attributed by Handley Page to the fail-safe construction and corrugated sandwich skin employed. The fact that the wing panels and trailing-edge structure are continuous across the nacelle, the latter being hung as a separate item, "no doubt prevented the wing from being burned off in flight."

Rolls-Royce state that there have been two auxiliary gearbox breather layshaft failures on the Dart 520 three-stage turbine engines. Both failures were identical and were associated with a certain manufacturing batch. Action has been taken to strengthen the layshafts.

In addition, the low-oil-pressure warning light switch has been repositioned to sense the oil pressure to the turbine bearings so that, in the event of the oil supply ceasing, an immediate indication is given by a red warning light, enabling feathering action to be taken before a major failure occurs.

Handley Page are investigating the introduction of an automatic cut-off in the fuel line which will operate should the pipe be fractured. Means of protecting the fuel line forward of the fireproof bulkhead are also being studied.

The aircraft which crashed had finished its flying trials—200 hours in the air—following its first flight earlier this year. Only one or two tests remained to be completed before a Certificate of Airworthiness was granted. The second prototype Dart Herald, say the manufacturers, is already near completion.

BREVITIES

COMET 4s will take over the daily Monarch service between New York and London on November 14, two days before the date announced by PanAm for daily 707 services between the two capitals. (PanAm's proposed date for the inauguration of services to Paris and Rome is Sunday, October 26.) Comets will leave London every day at 1015 hr local time, arriving at New York 1545 local. The return flight will leave New York at 2100 local and arrive at London Airport at 0845 local.

* * *

Mr. A. W. Smith, O.B.E., M.I.Mech.E., M.Inst.T., has been appointed a member of the Air Transport Advisory Council.

* * *

T.C.A. has sold nine DC-3s to Frontier Airlines. This U.S. local-service carrier recently cancelled an order for two F-27s.

* * *

American Airlines have arranged to sell 24 Convair 240s to Frederick B. Ayer and Associates. Ayer will offer them for sale at $250,000 for the 40-seat airliner configuration, and $385,000 for the executive conversion.

* * *

As this page of *Flight* went to press, the British Government granted permission to the Boeing 707 to operate from London Airport. Limitations as to height over communities were imposed (see p. 638).

* * *

In a draft Technical Standard Order (number N6b) circulated to the American airline industry by the C.A.A., proposals are put forward for changes in standards for runway dimensions and strengths.

* * *

Last Monday night five B.O.A.C. engineers, who declined to work overtime in accordance with a "work-to-rule" decision pending satisfaction of a pay claim, were dismissed. As a result, a strike brought B.O.A.C.'s movements from London Airport to a standstill.

Lufthansa received their first Viscount 814 on October 6. Delivery of the fleet of nine should be completed next March.

* * *

Air Ceylon are reported to be interested in acquiring Electras. (K.L.M. hold a large share in Ceylon's airline).

* * *

A new Dutch charter company, Konig Airtransport, has been established at Rotterdam. The fleet will initially consist of three Vikings; a DC-4 will probably be acquired later.

* * *

B.O.A.C. were due to open their South American service to Caracas yesterday, October 16. This service will shortly be extended to Bogota.

* * *

B.O.A.C.'s fleet of L.749s have now been withdrawn, the last Constellation service having been taken over by Britannias on October 7. The Corporation's Argonauts will be withdrawn from operation this month.

* * *

It is reported that Austrian Airlines, Viscount operators, may well be Europe's second purchaser, after K.L.M., of the Lockheed Electra. The airline is also in the market for Friendships; a Fokker demonstrator recently visited Vienna.

* * *

To finance their jet programme, National Airlines are offering for sale their entire piston fleet with the exception of six Convair 440s. Included in the 44 available aircraft are four DC-6s, eight DC-6Bs, four DC-7s, four DC-7Bs, four L.1049Hs, eight Lodestars and 12 Convair 340s.

* * *

An appointments bureau for those interested in employment in civil aviation has been set up by Mr. B. J. Snook and Mr. D. Wolfson, D.F.C. Known as PlanAvia International Aeronautical Appointments Bureau, the organization has offices at 338 Kilburn High Road, London, N.W.6.

Lined up at Renton are three of PanAm's six Boeing 707-120s. Farthest of the three, N709, was used to conduct the recent noise tests at London and Paris while N710 (the middle aircraft) carried out the Rome tests.

Two unusual specimens seen at this summer's Venice Aero Show were (left) a modified Klemm KI 35 of pre-war vintage, and (right) a Caproni Ca-139 powered by two 160 h.p. Walter Minor 6-III engines.

CLUB AND GLIDING NEWS

AMONG visiting aircraft at the Armstrong Siddeley Flying Club's "Tipsy Weekend" at Baginton were Tipsy Trainers G-AFRV and G-AISC from Newcastle and White Waltham, Fairey Junior G-AMVP, Tipsy Belfair OO-TIC, and the T.K. Group's Turbi G-AOTK. Although Monsieur Tips himself, designer of the Tipsy machines, was unable to come, he was represented by his two sons Maurice and Martin and their wives, and by Bernard Neefs, chief test pilot of Avions Fairey. Included in the programme was a mixed formation flight over Coventry, forced-landing contest, flour bag bombing, a demonstration of the Belfair by M. Neefs and an aerobatic display in the A.S. Club's own Tipsy, G-AFSC, by C.F.I. Harold Ashworth. At the evening dance at the Coventry Aeroplane Club, engraved pewter tankards, donated by M. Tips, were presented to the operators of each Tipsy present, and on the following morning—which was "somewhat marred by drizzle and thick heads," according to weekend organizer Ruth Sully—a colour film of the new Tipsy Nipper was shown.

THE Fair Oaks Cup was won by H. J. Pelham at the recent flying competitions held by Fair Oaks Aero Club. The winners of the club's navigation competition were D. Sole and H. Hall. An instructional course for the restricted R/T licence begins on October 29.

ANNUAL dinner of the Association of British Aero Clubs and Centres will be held at the Waldorf Hotel, London, on Friday, November 7, at 7 p.m. for 7.30. Further details are available from member-clubs or from the A.B.A.C. at 7c Lower Belgrave Street, London, S.W.1. Following a recent report in *Flight* concerning the advanced flying courses drafted by the A.B.A.C., the Association has received a number of inquiries for further details and has now produced a pamphlet describing both stages of the course syllabus, which is available on request.

GLIDING records recently confirmed by the Council of the British Gliding Association comprise: (1) women's British national and U.K. out-and-return, Mrs. A. Burns, 94 miles Lasham - Kidlington - Lasham, May 28; (2) two-seater U.K. out-and-return, J. Williamson and Mrs. A. Welch, 102 miles Lasham - Westbury - Lasham, May 28; (3) British national 100 km triangle, A. J. Deane-Drummond, Leszno - Rawicz - Gostyn - Leszno, June 17, 47.6 m.p.h.; (4) British national 200 km triangle, A. J. Deane-Drummond, Leszno - Sroda - Krotoszyn - Leszno, June 13, 45.4 m.p.h.; and (5) U.K. 200 km goal speed, H. C. N. Goodhart, Nympsfield - Great Yarmouth, made on August 2, at 58.8 m.p.h.

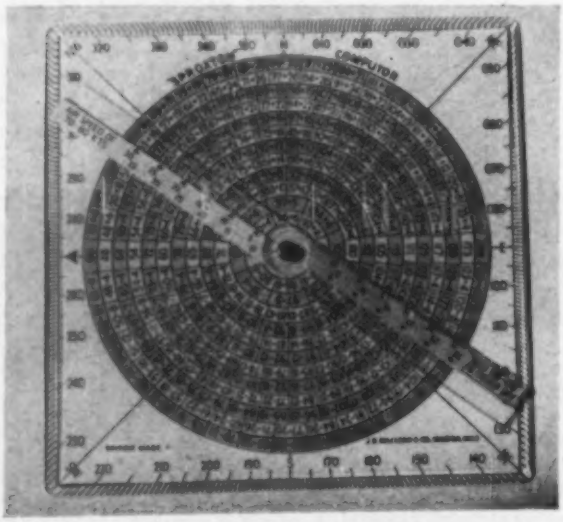
AN order for a Slingsby Swallow for the Yorkshire Gliding Club was announced at the club's recent annual general meeting at Sutton Bank. This aircraft will be the first club machine to be fully equipped for cloud-flying. It was reported at the a.g.m. that, during the year, 2,237 launches had been made at Sutton Bank and 1,600 at Sherburn. Awards made at the meeting included trophies for height and distance records presented by Mrs. F. N. Slingsby to Ron Helliwell, and gifts to Mr. D. N. Sharpe (club treasurer) and Mr. Bentham (club auditor) in appreciation of their long and active services for the club. Mr. J. C. Reussner was re-elected chairman, and other appointments to the club committee included Mr. C. Riddell, secretary, and Mr. D. Hill, treasurer.

THE first issue of a quarterly newsletter produced by Slingsby Sailplanes, Ltd., containing details of the company's current developments was circulated earlier this month. It quotes a price of £750 ex-works for the Swallow and £490 for a complete kit of parts for this machine. Working under John Simpson, a school-teacher member of Lasham Gliding Centre and London Gliding Club, the pupils of Leighton Park School, Reading, have completed the construction of a T.21B two-seater from a Slingsby kit of parts. Other news of Slingsby products includes a report of a 305-mile flight, averaging 53 m.p.h., from Brantford, Ontario, to Wurtsboro, New York, achieved recently by Gordon Oates of Toronto, a member of the syndicate which purchased the first Skylark 3 to be exported to Canada.

A NEW navigational aid for light-aircraft pilots, the A.S. computer, is now available from the Association of British Aero Clubs and Centres, 7c Lower Belgrave Street, London, S.W.1. Designed by Alan Sproxton, until recently chief flying instructor of the Surrey Flying Club, the new computer has as its main function the solving of one basic problem—given track, airspeed and wind velocity, to find course and groundspeed. The main computer (illustrated left) can also be used as a protractor, and its accompanying unit, a Parnell Rotarule, can be used for time/speed/distance calculations and various unit conversions.

In use, the computer is placed as a normal protractor on the map, with central hole over the starting point. The track is noted and a pencil mark is made on the map adjacent to the angle on the computer edge corresponding to the forecast wind-direction. The computer is rotated until its red arrow points along the track, and the cursor scale appropriate to the airspeed is lined up with the wind-direction mark on the map. The instrument is now set and may be removed from the map. The wind-strength scale on the cursor bar is used to read off the appropriate figures on the main computer. This reading might be "110+9," indicating a groundspeed of 110 m.p.h. and a drift angle of +9 deg.

A number of limitations have been accepted in the design of the computer. Its use is confined to airspeeds of between 70 and 90 kt, and an amount of interpolation is often needed. Accuracy is not as high as that of the Dalton computer, but is considered at least as good as the accuracy with which a course can be flown in light aircraft. Maximum errors are 2 deg (course) and 3 m.p.h. (groundspeed). Price of the A.S. computer, complete with Rotarules, instructions and leather case, is 35s.



The Sproxton computer described above. It measures 5in square.

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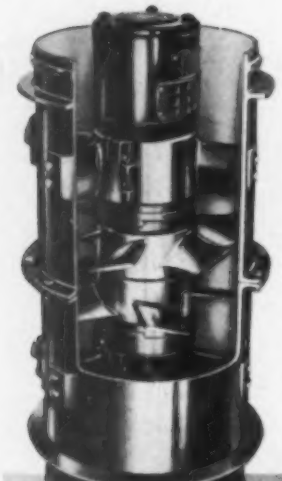

AIRCRAFT FANS for CABIN VENTILATION

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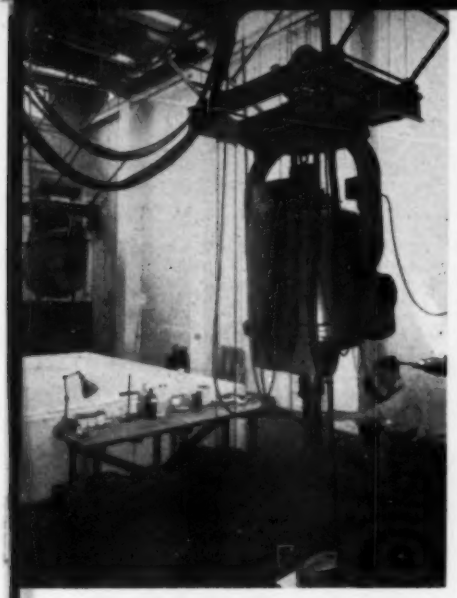


Radiography is one of the most valuable tools in the investigation of inaccessible portions of aircraft structure. In this photograph are seen two of the A.I.D.'s largest X-ray machines, with outputs of 400 and 1,000 kV.

THE Aeronautical Inspection Directorate is one of several inspection directorates of the Ministry of Supply (the others deal with such subjects as armoured fighting vehicles, chemicals, armament and clothing). As such it is responsible for the overall maintenance of quality and integrity in aircraft, engines, aeronautical equipment and materials for the British Fighting Services; in addition, it is charged with similar control over the guided weapons of the R.A.F. and Army.

Organized into divisions, each dealing with a particular aspect of the Directorate's work, the A.I.D. has a total technical staff of about 1,000. Many of these are inspectors, some of whom are resident in offices in important towns and are responsible for a number of local contracting firms, and others are stationed permanently at major aircraft companies. The A.I.D. Laboratories at Harefield, Middlesex, maintain the quality of technical standards throughout the industry by checking samples sent in by the inspectors and by developing new testing techniques.

Last week we were able to see something of the current work of these laboratories; and, although our hosts were highly discriminating in choosing exhibits, the latter sufficed to give an indication of the tremendous breadth and scope of the work done. Throughout, the accent is on precision.

One of the largest sections is that devoted to non-destructive testing and radiology. An accompanying photograph depicts two of the large X-ray equipments, which are employed in the radiographic examination of dense metals in thicknesses up to about 7in or in the inspection of enclosed and inaccessible portions of structures—with particular reference to crack-detection. In another part of the same section it was possible to inspect exhibits which emphasized the remarkable diversity of equipment possessed by the laboratory for the inspection of raw material and workpieces. Methods used include pulsed and c.w. ultrasonic techniques, magnetic flow, current flow and coil methods, eddy currents, and fluoroscopic or radiographic (isotope) means. The laboratory is fortunate in being able to obtain the finest equipment from any country, and British, American, German, French and other nations have all contributed to its inventory.

In the metrology section, the proverbial "thou" is regarded as a brutishly coarse tolerance. It was evident that particular emphasis is being applied to the investigation of miniature ball-bearings, which are of extreme importance to the proper functioning of guided weapons and advanced aircraft systems. One apparatus measures the diameter of steel balls to an accuracy of five millionths of an inch, and it was possible to investigate the running accuracy of miniature ball-bearings in the assembled form and to inspect 1mm jewel bearings.

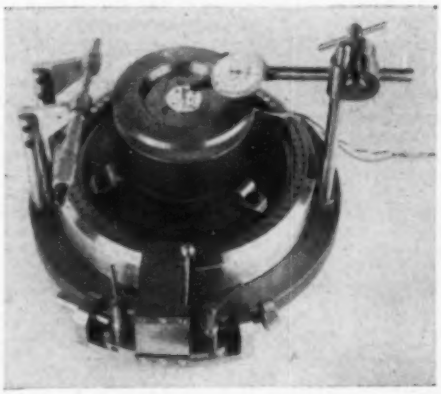
In the guided-weapons section, a "clinic" has been constructed which, when it has been in operation a little longer, will contain no particle of dust with a size larger than one-third of a micron. As is usual in such environments, the operator was wearing a lint-free nylon garment, and it is likely that a mask will be necessary to capture moisture from his breath. Pencils and paper are strictly taboo, and even knurling—such as might be found on a small screwdriver—will not be permitted.

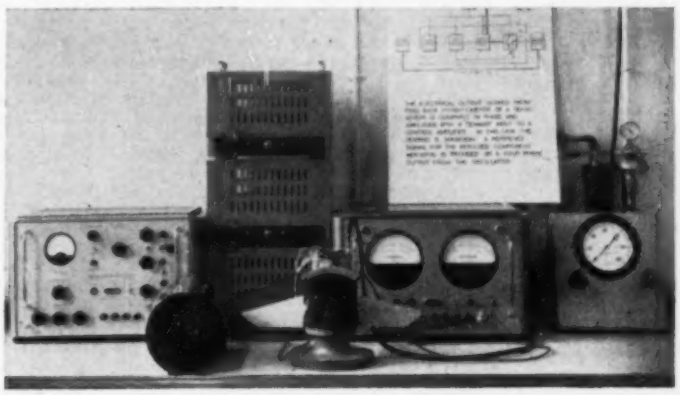
Also in the G.W. laboratory was to be seen a control-system transfer function rig, the subject of an illustration below. The servo system under test was salvaged from a Fireflash test vehicle, three of the control fins being in place and the fourth being replaced by an angular pointer. A known sinusoidal input signal was obtained from a variable-frequency oscillator, together with a 4-phase reference signal. The servo input was derived electrically from a feed-back potentiometer, and this signal was then compared in phase and amplitude with the known demand input. Polar diagrams could be examined in which lag and accuracy of the potentiometer wiper were plotted for a variety of input frequencies.

Another interesting programme concerned the problem of detecting resonance inside "black boxes" and other equipment which cannot be inspected visually. In this case a Goodman vibration generator was used to energize a 6-lb mass (representing the black box) to which were attached small 3-oz masses (representing a portion which might resonate), the whole being subject to a constant acceleration of 5g over a range of frequencies. The complete 6-lb mass under test was carried by an aluminium transducer tube, around the periphery of which were disposed numerous printed-circuit strain-gauges. The output from these gauges (in theory sinusoidal, according to the applied frequency) was passed to a valve modulator to give a straight-line output; resonance, however, causes discontinuities, which can be plotted against frequency with satisfactory accuracy. Yet another programme was concerned with the live testing of multi-pin butt connectors. A broken lead or a stuck pin could render a complete missile mission abortive, and specimen connectors are being subjected to tests of some 50,000 cycles.

After passing through departments engaged in the investigation of high-pressure hydraulic systems, aviation petrol knock ratings, new autographic methods for measuring creep, and the determination of luminous flux, intensity, transmission, reflection, absorption and luminance (even down to the low energy-levels associated with luminous dials) we concluded our tour with an examination of flying clothing and safety equipment. Lengthy research has been applied to the evaluation of parachute fabrics, ropes and cordage, air-ventilated suits, partial-pressure suits, tropical flying clothing, immersion suits, dinghies, survival equipment and all the other multitude of accoutrements of Service aircrew. It is not the A.I.D.'s job to develop such equipment, but they are brought in to investigate—for example—variations in airflow through the fabric of a parachute, or to assist in the evaluation of improved testing methods for continuous-filament glass fabrics. It is in such second-line and third-line support that the laboratories of the A.I.D. provide a solid foundation upon which the whole industry can build with confidence.

The device illustrated on the left, below, is a dividing head which was developed in the A.I.D. laboratories for the investigation of angular errors in synchros; it can read to within 0.25 min of arc. The larger illustration depicts the bench rig for investigating the performance of a guided-weapon servo system. In the centre can be seen the control surfaces of a Fireflash, the test being briefly outlined in the text above.





R.F.C. Scout D, A.1747 (80 h.p. Le Rhône). Note shortened ailerons, and wing-tip skids moved farther outboard.

HISTORIC MILITARY AIRCRAFT No. 18

PART III

By J. M. BRUCE, M.A.

THE BRISTOL SCOUT

THE structure of the Bristol Scout had steadily evolved from that of the Scout A of 1914 to the Scout D, which incorporated lessons taught by war, with its need for aircraft production on a scale undreamt of when the 1914 Olympia Show was opened. But the evolutionary modifications were of detail; basically the airframe remained a simple structure, executed in the conventional materials of the period.

Each of the four longerons was in two parts: the forward portion was of ash, the remainder of spruce. The two portions of each longeron were joined by splices. Each splice was 250 mm long and was effected by a glued scarf joint with four ¼in copper rivets, the whole being bound with whipcord. In the upper longerons the splice occurred in the bay immediately in front of the dashboard; in the lower it was in the bay behind the pilot's seat. The longerons were solid throughout their length; forward of the cockpit they were 30 mm square, and the after portions tapered from 30 mm to 18 mm square.

Spruce was employed for the spacers of the fuselage. Those in the front part were 30 mm square, and all except the diagonal were left solid. The diagonal strut and all spacers abaft the cockpit were spindled out, and the upright and transverse spacers in the rear fuselage were of progressively smaller section, the rearmost being 20 mm square. The sides of the fuselage were cross-braced by tie-rods: from the back of the cockpit to the sternpost, 4-B.A. rods with fork joints were used, apart from one 2-B.A. rod in the rearmost bay. The forward fuselage had 2-B.A. tie-rods with fork joints. Top and bottom cross-bracing consisted of tie-rods in front of the cockpit; behind that point 14 s.w.g. piano wire was used. The corners of the cockpit opening were reinforced with ⅛in ash three-ply fillets. The rounded top decking was formed by light stringers on plywood formers, and contained a small locker let into the back of the cockpit.

Of steel plate, the engine-bearer had a secondary, half-depth, plate attached to the first spacers, 290 mm aft. The undercarriage consisted of two simple ash vees, cross-braced by 25 cwt cable in the early Scouts C and by ¼in B.S.F. Rafwires on later machines; there was a single wooden spreader bar. The axle was bound to each vee by twelve feet of ¼in elastic cord wound at about 10 lb tension. Palmer Cord Aero tyres of 700×75 mm were fitted.

The mainplanes had spruce spars, spindled out between the compression ribs, of which there were two in outboard positions. Internal cross-bracing of the basic wing-structure consisted of either Bullivant Mark P 2,000 lb cables of 0.126in diameter or 2-B.A. tie-rods; the outermost panel was braced by 14 s.w.g. piano wire. Leading edge and wing-tips were formed from one continuous piece of steel tubing; the trailing edge was also made of steel tubing.

For the ailerons there were spruce spars and steel-tube trailing edges. The lower ailerons were actuated direct from the control column; the cable, which was the 2,450 lb Bullivant Mk Q, 0.137in in diameter, ran internally along the rear face of the front spar, over a pulley, and out to the aileron control lever. The control levers were connected to the aileron secondary spar by A.G.S.307 tie-rods, and upper and lower control surfaces were connected by Rafwires, type A.G.S.347. Spanwise balance cable for the upper ailerons was 1,500 lb Bullivant Mk O of 0.115in diameter.

Landing and flying wires on early Scouts C consisted of 20 cwt cable, as did the athwartships bracing of the centre section. Incidence bracing of both interplane and centre-section struts was by 15 cwt cable. Late-production Scouts were braced by Rafwires: landing and flying wires were of type A.G.S.348, and the incidence wires were A.G.S.347.

A length of 22 s.w.g. steel tubing of 1in outside diameter formed the rear spar of the tailplane, and the leading edge was of 24 s.w.g. steel tubing of ½in o.d. The main spar, 420 mm abaft the leading edge, was of spindled spruce. Construction of the elevators was similar, but their trailing edges were of ½in o.d. tubing, their intermediate spars were of ½in×22 s.w.g. steel tubing, and they had steel ribs welded to the basic structure. The rudder was also an all-steel unit; the outline of ½in×24 s.w.g. tubing was welded to the 1¼in×18 s.w.g. axis-tube, and the steel ribs were welded in place. A late modification was the fitting of an enlarged rudder; its area was 8.15 sq ft whereas the earlier standard rudder was of 7 sq ft. In shape and construction the larger surface was identical with the earlier but it could be distinguished by its three ribs.

The entire airframe was covered with fabric, apart from the forward top decking and the side panels immediately behind the engine cowling; these were of aluminium sheet.

Although the Bristol Scout's operational use by the R.F.C. in France ended soon after the Battle of the Somme, it continued actively in the Middle East. In Palestine the type was used in small numbers by Nos. 14, 67 (Australian) and 111 Squadrons. On March 22, 1917, Nos. 14 and 67 had between them seven Bristol Scouts. These two units then composed the Fifth Wing. On April 20, 1917, the Wing had nine Bristols, seven of which were unserviceable, but on October 27 only one remained. By that date the R.F.C. in Egypt and Palestine had been reorganized, and the new No. 111 Sqn. had the sole serviceable Scout on its somewhat variegated strength. The activities of the Scouts in Palestine seem to have been confined to escort duties.

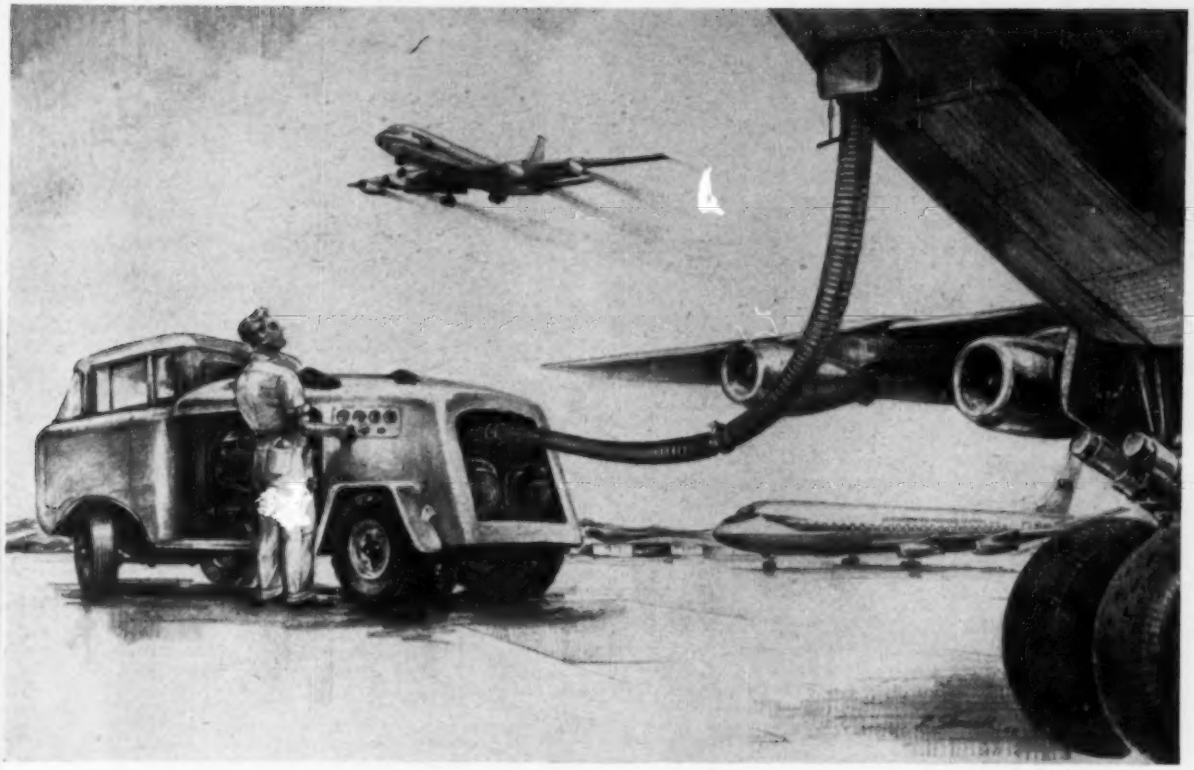
Altogether 32 Bristol Scouts were sent to the Middle East, 26 in 1916 and six in 1917. The majority were in Egypt, where some were flown for training purposes by the 20th Wing at Abu Qir. Early in April 1917 new German single-seat fighters appeared in Mesopotamia and were so obviously superior to the British aircraft then in use that British air superiority was endangered. The only R.F.C. unit then in Mesopotamia was No. 30 Sqn., which had no fighting aircraft on its strength. In anticipation of the re-equipment of the opposing German units No. 30 had asked the War Office for up-to-date fighters. Some Spads were promised but obviously could not be delivered for several weeks. As a stop-gap, a few Bristol Scouts were transferred to Mesopotamia from Egypt.

The Bristols were unshipped at Basra, where they were hastily assembled by the Aircraft Park. No. 30 Sqn. was at Baghdad, but its Flights were dispersed, "B" to Baquba and later (April 8, 1917) to Fort Kermea; "C" to Kasirin, then (April 7, 1917) to Kuwar Reach. On April 5 the first of two Bristol Scouts was flown the 750 miles from Basra to the front; a second Bristol followed on April 17. On April 22 one of the Bristols, flown by Lt. M. L. Maguire, engaged a Halberstadt in full view of the British troops: Maguire shot the wings off his adversary, which crashed behind Istabulat.

With Baghdad secure and the Turkish ground forces driven back, two Flights of No. 30 Sqn. were sent back to Baghdad. The two Bristols stayed with the third Flight, which was at Sindiya but moved a few miles down the Tigris to Jadida in June.

Two months later No. 63 Sqn. arrived at Basra. Its first R.E.8 to reach Baghdad arrived there on September 14, 1917. After early misfortunes the squadron established itself at Samarra by November: it had two Flights of R.E.8s for reconnaissance and one of Spads, Martinsydes and Bristol Scouts for fighting duties. No. 63 Squadron's Bristols were the last of their type to see service in Mesopotamia and probably did not long survive.

The R.N.A.S. had sent Bristol Scouts overseas long before the R.F.C. did so. To participate in the Dardanelles campaign, No. 2 Wing, R.N.A.S., arrived at the Isle of Imbros late in August 1915, bringing with it 22 aeroplanes, 16 pilots, 200 men, maintenance equipment and spares. Among the aeroplanes were four Bristol Scouts with 80 h.p. Gnôme engines. Towards the end of 1915 six more arrived; they were armed with Lewis guns, and reached



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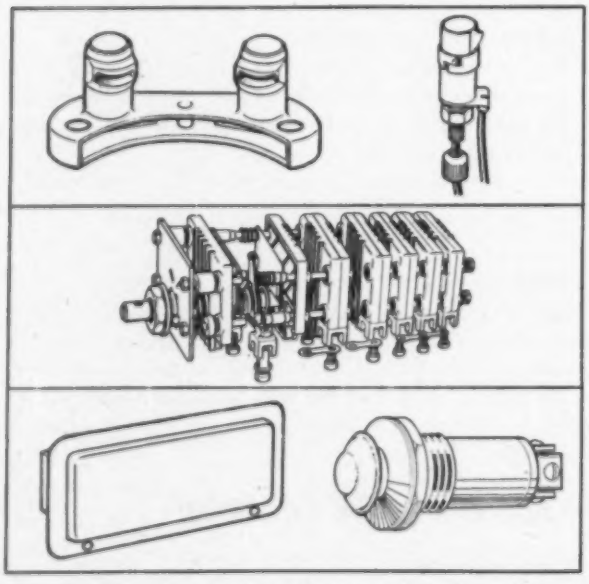

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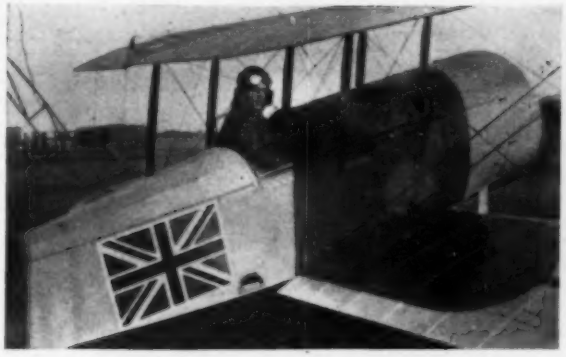

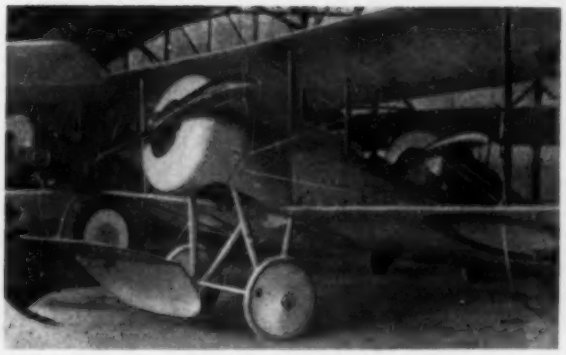

(Left) Scout C of No. 2 Wing, R.N.A.S., Imbros, with fixed unsynchronized Lewis gun. (Right) Another Imbros Scout C, with bombs between front legs of undercarriage vees.

THE BRISTOL SCOUT . . .

the Dardanelles in time to keep the air clear of enemy aircraft during the evacuation of the Allied troops.

At the end of May 1916 a new scheme for the distribution of British naval aircraft in the Aegean was introduced. In the previous month an aerodrome had been established on the island of Thasos. It had been made as an advanced landing-ground for R.N.A.S. aircraft from Mudros and French machines from Salonika, but it was also well situated for launching attacks against the flank of the Bulgarian army on the Macedonian front. At the end of May 1916 a composite unit was sent there for that purpose. Its equipment consisted of three Henri Farmans, one Nieuport, and two Bristol Scouts from the R.N.A.S., together with a Flight of Nieuports and Maurice Farmans of the French air service. This composite unit was placed under R.N.A.S. command and was named "A" Flight. The French component was withdrawn to Salonika early in July, whereupon the R.N.A.S. seaplane unit at Stavros was transferred to Thasos to reinforce "A".

Whatever those two Bristol Scouts may have done, their accomplishments seem not to have found their way into any history. One of the Scouts of No. 2 Wing flew from Imbros with four Henri Farmans on December 13, 1916, to bomb the railway bridge over the River Maritsar at Kuleli Burgas. No doubt the Bristol acted only as an escort on that occasion, but No. 2 Wing carried bombs on their Bristols when it was necessary and possible to do so. The bomb racks were made and fitted at Imbros. They could hold four small bombs and were fitted to the underside of the fuselage, between the forward legs of the undercarriage vees. In that position the noses of the bombs were virtually inside the lowest part of the engine cowling, and it is difficult to see how the bombs could fail to strike some part of the undercarriage when they were released.

Even more hazardous was No. 2 Wing's method of fitting Lewis guns to their Scouts. Not for them the slewed approach to the target demanded by obliquely-mounted guns, nor such effete devices as armoured propellers and interrupter gears: they fitted their Lewis guns to the fuselage side, parallel to the line of flight, and fired through the propeller arc regardless of consequences. Inevitably the unprotected propellers were occasionally (probably frequently) shot through. When that happened without the immediate disintegration of the propeller, the bullet holes were plugged with wood and the blades bound with insulating tape. (It is not irrelevant to recall Capt. Norman Macmillan's reminiscences of the Vickers guns on No. 45 Squadron's Sopwith 1½-Strutters. As recounted in the history of that aircraft [*Flight*, October 5, 1956, page 586], when the Ross interrupter gear was fitted it was possible in emergency to fire the gun direct by the hand trigger. It then fired freely, unregulated by the interrupter gear, and gave hard-pressed pilots a faster rate of fire. Nevertheless, Capt. Macmillan could not recall a single instance of any propeller being shattered by such action.)

Some of No. 2 Wing's Bristol Scouts had two Lewis guns: in some cases one was mounted on each side of the fuselage; other machines had the second gun above the centre section on a home-made mounting, the return spring of which consisted of rubber shock-absorber cord.

Throughout its service with the R.F.C. and R.N.A.S. the Bristol Scout had many arrangements of armament. Several variations of the outward-pointing Lewis machine-gun appeared, differing only in the manner of attaching the gun to the fuselage. Various methods of carrying a Lewis gun above the centre section were also tried. In all those of which photographs have survived the gun could be swung backwards for re-loading and upward shooting, and all required a cut-out to be made in the trailing edge portion of the centre section. The cut-out varied in size and shape until the late Scouts D appeared with their V-shaped notch and standardized gun bracket.

In some cases the over-wing Lewis gun could be fired from the cockpit by means of a Bowden cable, but on other Scouts the pilot evidently had to reach up and operate the trigger manually. At least one Bristol had a trigger extension on the spade grip, which probably made the firing of the gun less of a contortion.

None of these devices permitted accurate shooting, and there can be little doubt that only the lack of a British synchronizing mechanism prevented the Bristol Scout from making a considerable name for itself as a fighter. Experiments with interrupter and synchronizing gears began in 1915, and in December of that year the Vickers-Challenger synchronizing gear was considered sufficiently successful to justify its production in quantity. This gear was used with the Vickers machine-gun, but an acute shortage of guns delayed deliveries of the synchronizing mechanism for two months.

The first aeroplane fitted with any form of machine-gun synchronizing gear to join the R.F.C. in the field was a Bristol Scout which had a Vickers gun and the Vickers-Challenger mechanism. The gun was mounted on the port upper longeron. This Scout reached France on March 25, 1916—a full two weeks before an example of the Fokker interrupter gear fell into British hands. On April 8, 1916, a Fokker monoplane was captured intact after a forced landing in the British lines. By that time its secret was no longer exclusive; moreover, its depredations had been checked by those redoubtable pushers the D.H.2 and F.E.2b.

A few more Vickers-armed Bristols went to France in 1916 and, as noted in the early pages of this history, one of them was allotted to No. 13 Sqn., where it was flown by Albert Ball. Why more Bristol Scouts were not fitted with the synchronizing gear and sent to France in worthwhile numbers has never been adequately explained. By the end of March 1916 no fewer than 191 Bristol Scouts C and D had been delivered to the R.F.C. and R.N.A.S., and it is of some interest to speculate as to what course the war in the air might have taken if the R.F.C.'s share of those aircraft had all been fitted with synchronized machine-guns and sent to France. Ball's experience may, of course, have been typical of the early gun gear on the Scout; and the availability of the Nieuport Scout and the prospect of the Sopwith Pup may have contributed to the seeming indifference towards the Vickers-armed Bristols.

It has not been possible to establish whether Bristol Scouts were used by the R.N.A.S. in that Service's experiments with interrupter gears. What is certain is that there was at one time at the R.N.A.S. Station, Isle of Grain, a Scout C which had a peculiar fairing on top of the fuselage immediately in front of the cockpit (see illustration on p. 545 in Part II of this article, *Flight*, October 3). The size and shape of this fairing were such that it might well have accommodated a machine-gun, and it would not be unreasonable to postulate that the aircraft in question played a part in the R.N.A.S.'s experiments in the synchronizing of Lewis machine-guns.

(To be continued)

R.N.A.S. Scout C with two Lewis guns.

Correspondence

The Editor of "Flight" is not necessarily in agreement with the views expressed by correspondents in these columns. Names and addresses of writers, not for publication in detail, must in all cases accompany letters.

The Comet Achievement

THE Comet appears to be following the lines of the traditional British success story: first, early success and the usual complacency, then disaster and much self-criticism, and, finally, triumph after the hard climb back. Good luck to everyone concerned, and let us hope that the orders flow in faster than de Havilland can meet them. And, by the way, surely "The Comet Story" is an absolute gift to any film company with a couple of million pounds to invest.

If I may be allowed one comment on the current differential-fares controversy, it is simply that there appears to be some confusion over the significance of time, as compared with distance. For example, if on the North Atlantic run both jet and turboprop aircraft make the same number of journeys within a given period of time, how do operators propose to make full use of a jet aircraft's greater speed? It appears that both the Comet and the Britannia will make one flight daily, and since the Britannia carries a larger payload and has a first cost comparable with that of the Comet, what factor determines which is the cheaper aircraft to operate? As far as earning capacity is concerned, much will depend, of course, on load factors.

I would expect jet aircraft to show to advantage on the very-long-range routes, such as London to Hong Kong, but here again, unless flights are made on a daily basis it is difficult to see how there can be any reduction in the number of aircraft required, or their crews. And as for fast schedules, are passengers going to take kindly to spending, say, four hours of luxury in a jet aircraft, only to be dumped at some airport in the small hours of the morning?

I hope I am not being unduly pedantic, but in mass air-travel, prestige and glamour mean little or nothing compared with cheap fares—the cheaper the better. As far as practical airline schedules are concerned, the turboprop does appear to be a more suitable vehicle for mass travel than a jet aircraft, and that should favour a lower fare-structure for the slower aircraft.

Twickenham, Middx. O. S. RICHARDSON.

JUST to add one more puncture to our American cousins' somewhat flat-looking ego, I think I'm right in saying that this is the first time the Blue Riband of the transatlantic air has been recaptured by a British aircraft from a British aircraft. Reason, perhaps, for another "brickbat" (I quote) memorial.

Also, I believe that Britain was first across with piston, turboprop *and* jet. Surely a remarkable performance.

Bristol, 3. S. LLOYD.

Glamour for Grub Street?

ROGER BACON'S light-hearted strictures about the location of press-information material in the S.B.A.C. Press Tent at Farnborough made amusing reading.

To be serious for a moment, the reasons for which we this year added "a gloomy ante-chamber strewn with hazardous obstacles in the form of company stands and information racks" were (a) to centralize all such material and (b) to ensure that journalists would have plenty of room—in the main part of the tent—in which to walk, talk and conduct their business. In 1957 a combination of paper, gusts of wind, and feet made the Press Tent look like a paper-printing factory.

Next year we will try to cheer up the "gloomy ante-room" for Roger Bacon's benefit!

London, W.1. ALEXANDER JOHNSTON,
Head of Information Dept.,
Society of British Aircraft Constructors.

Air-Victory Scores

THE history of American military flying, since the U.S. Army bought its first aircraft 50 years ago, is well told in the anniversary issue of *Air Force*, published in Washington by the Air Force Association.

But the war "aces" are strangely handled. Nine aces of World War I are listed, headed by Rickenbacker (26 victories) and Frank Luke, the balloon-buster, with 18. The two lowest have ten each.

Only ten pilots are in the World War II list. Rather odd, I thought, in view of the much longer and greater U.S. air effort. They are headed by Maj. Richard Bong (40) and Maj. Thomas McGuire (38). At the foot of the list is Col. David Schilling, with 22.5 victories. Next come eleven "jet aces" of the Korean War. Top scorers, Capt. James McConnell, Jr. (16) and Maj. James Jabara (15). At the lower end of the scale, six pilots are credited with ten each.

Puzzled by the apparent discrimination against the World War II aces, and by the fact that the lowest score was 22.5 against ten in the other wars, I looked for the name of Col. Walker Mahurin, who, for a time in 1943, at the age of 25, was the top American scorer in this country, flying Thunderbolts, escorting Forts deep into Germany in daylight. I looked in vain. Mahurin was shot down in France when his score was 21, walked out, and notched a Jap before *that* war ended. Score, 22.

Was it because of Mahurin that the list ends at the curious figure of 22.5? He went to Korea, scored three more victories, then was shot down. Under torture and brain-washing he "confessed" to having dropped bacteriological bombs. Senior American officers with fighting records have spoken to me of Mahurin with affection and respect—and with regret, because of the saddening effect of his experience on his once gay nature.

The law pays scant regard to signatures and promises made under duress. I do not attribute anything but the best motives to the editors of *Air Force*, but it is no use pretending that Mahurin did not exist. Let him have his rightful place among the valiant, and leave stone-throwing to those who can match his achievements and his sufferings.

London, E.C.4. MICHAEL UNSWORTH.

Bristol Scout Armament

IN Part I of "The Bristol Scout" J. M. Bruce quotes a note of mine on Lanoe G. Hawker, V.C. I knew Hawker during 1915-1916, when he commanded No. 24 (D.H.2) Squadron, Royal Flying Corps; but, as might be expected, it was not until very much later, when I was concerned with the historical aspect of that period in connection with the Official Air History, that I got to know many of the details that had made him one of the outstanding members of the R.F.C.

With regard to the arming of the Bristol Scout at the date mentioned, I think it can be established that Hawker had a Lewis gun fitted—probably within reach of his hand (for drum-changing)—firing outside the airscrew zone. The Foster gun-mounting came several months later and was designed in my old squadron (No. 11) when we had Nieuport Scouts, etc., in addition to our Vickers "Gun-Buses." Someone may put me right if I suggest that Lanoe G. Hawker had his gun on the centre-section, firing at a slight upward angle. The alternative, of course, would be alongside the cockpit, firing to the front but to the side.

Sgt. Foster's mounting (the result of close co-operation between that excellent N.C.O. and Capt. H. A. Cooper) held the gun horizontally above the centre-section and allowed it to come back and sit vertically in front of the pilot, who then changed drums before returning it on its curved rail to its horizontal operating position. Two of the mountings were made and used in my squadron, and Foster was then sent back to the U.K. to supervise further production.

It may be, of course, that drum-changing may have been ruled out in the case of Hawker's device. After all, one had 57 rounds in the Lewis gun drum at that period, and unless one risked trouble (a blued barrel, to say nothing more than that) one did not make a habit of firing bursts of more than five to ten rounds. It was not easy, though. The 57 went away in five seconds!

Chester. A. J. INSALL.

[J. M. Bruce returns to the subject of Bristol Scout armament in Part III of his article, on pages 644-645 of this issue—Ed.]

Naming the NA.39

MAY I venture to suggest the name Piranha for the NA.39 strike aircraft? This is in the name of a small but very vicious fish found in South America.

Ringwood, Hants. DANIEL MCMAHON.

FORTHCOMING EVENTS

Oct. 16-17. British Interplanetary Society: Space Medicine Symposium and Twenty-fifth Anniversary Dinner.
Oct. 17. Fair Oaks Aero Club: Annual Dinner and Dance.
Oct. 21. Institute of Transport: Visual Aids Meeting, and Aviation Films.
Oct. 22. Kronfeld Club: a.g.m.
Oct. 22. Radar and Electronics Association: "Fatigue of Metals," by Maj. P. L. Teed.
Oct. 23-24. AGARD Symposium, "Escape and Survival" (Copenhagen).
Oct. 23. British Institution of Radio Engineers (Scottish Section): "Flight Evaluation of Airborne Electronic Equipment," by H. G. Hinkley (at Glasgow; and at Edinburgh on Oct. 24).
Oct. 27. R.Ae.S.: "The Bloodhound," by D. J. Farrar.
Oct. 28-29. AGARD Assembly, Copenhagen.
Oct. 29. R.Ae.S. Graduates' and Students' Section: Film Show.
Oct. 29. Kronfeld Club: "Aircraft at Leszno, 1958," by Peter Brooks.
Oct. 31. Surrey Flying Club: Annual Dinner and Dance.

R.Ae.S Branch Fixtures:—Oct. 20, *Glasgow*, "Propulsion Systems for Helicopters," by Dr. A. W. Morley; *Henlow*, "Guidance and Control," by L. H. Bedford. Oct. 21, *Luton*, "Fatigue Testing of the Fokker Friendship," by E. J. van Beek. Oct. 23, *Bristol*, film show; *Southend*, "Air Safety—Work of the Air Registration Board," by W. Tye. Oct. 29, *Hatfield*, "Recent Developments in Aircraft Casting Manufacture," by R. W. Eade; *London Airport*, brains trust; *Hereford*, "Landing Hazards on the Moon, and Use of Space Stations," by A. F. Collins; *Weybridge*, "History of the Supermarine Organization," by A. N. Clifton.

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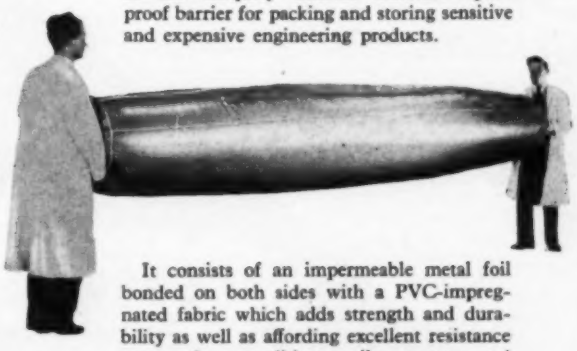

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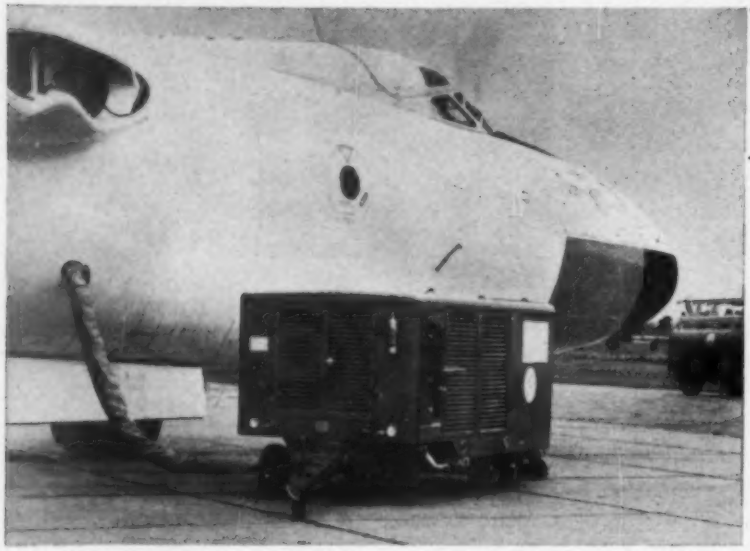

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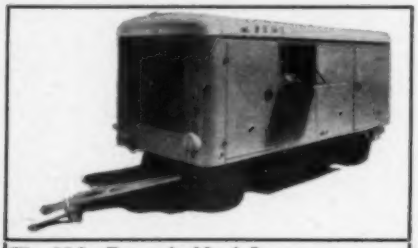

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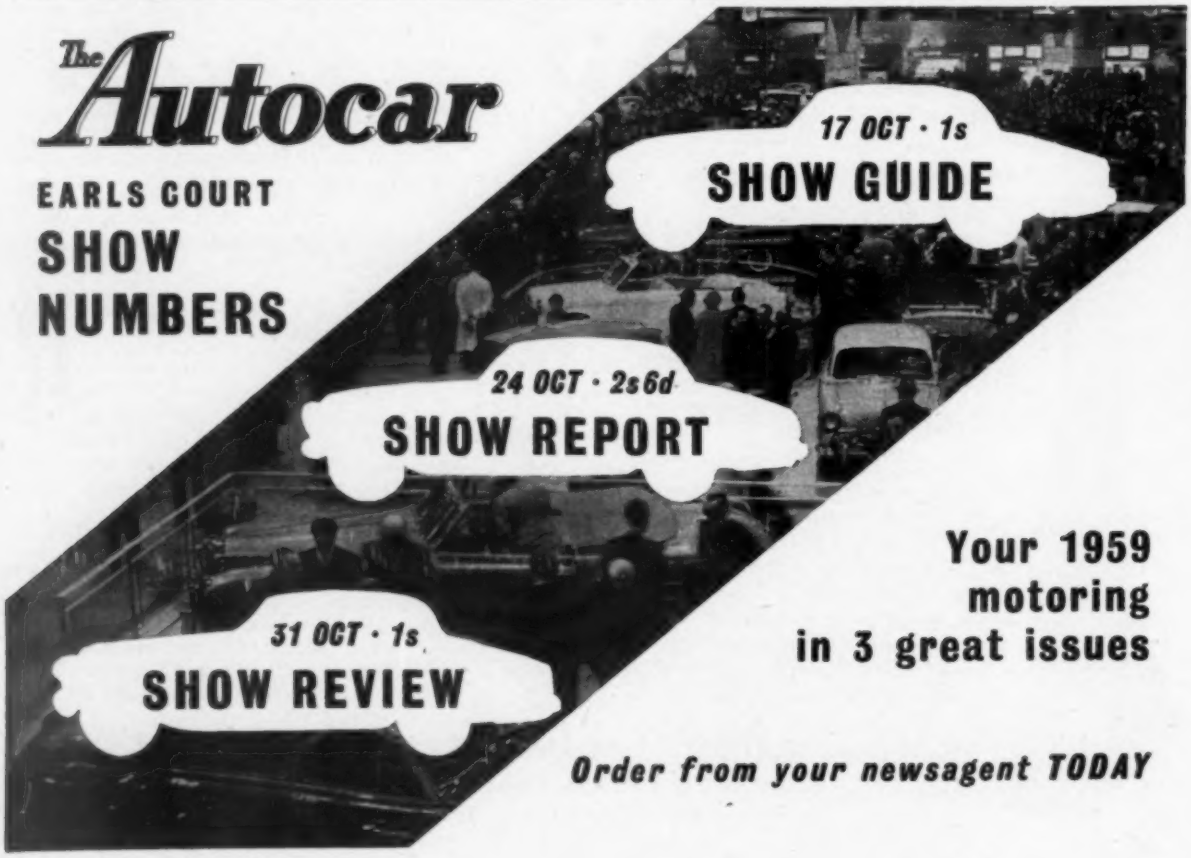

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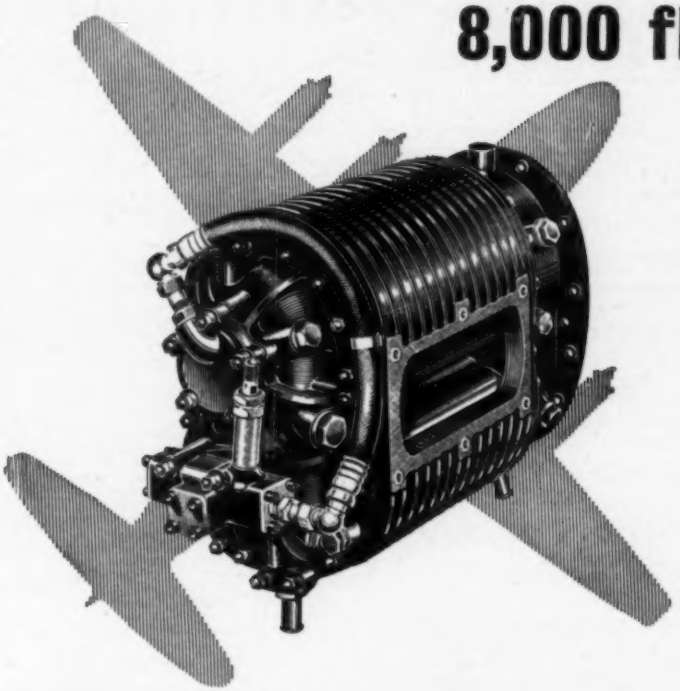

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PUBLIC ANNOUNCEMENTS

AIR TRANSPORT ADVISORY COUNCIL

THE AIR TRANSPORT ADVISORY COUNCIL give notice that they have received the undermentioned applications to operate scheduled air services:—

FROM Skyways, Ltd., of 7 Berkeley Street, London, W.1: Application No. 193/7 for an extension from 26th October, 1958, to 26th October, 1968, of the period of approval of the Colonial Coach Class Service which they are authorised to operate on the route London (Stansted) - Malta (Luqa) - Cyprus (Nicosia) at a fortnightly frequency with York and Hermes aircraft, and which they have previously applied to operate at a weekly frequency.

FROM Eagle Airways, Ltd., of 40 Edgware Road, London, W.2: Application No. 1042/2 for an increase in frequency from four to seven return flights weekly on the Normal Scheduled Service which they are authorised to operate with Viking and/or Viscount aircraft on the route London Airport and/or London (Blackbushe) - Lyons (optional technical) - Pisa.

FROM B.K.S. Air Transport, Ltd., of Berk House, Baker Street, London, W.1: Application No. 2263 for a Normal Scheduled Service with Dakota and Ambassador aircraft for the carriage of passengers, supplementary freight and mail between Southend and Rotterdam at a frequency of one return flight daily from 20th April to 10th May, 1959.

FROM Derby Aviation, Ltd., of Derby Airport, Burnaston, Derby: Application No. 2264 for a U.K. Internal Service initially with Dakota and Marathon aircraft and later also with Herald aircraft for the carriage of passengers, supplementary freight and mail on the route Manchester (opt.) - Cardiff - Bristol - Guernsey (opt.) - Jersey at an initial frequency of three return flights weekly increasing later to 14 return flights weekly for seven years from 1st January, 1959.

FROM Airlines (Jersey), Ltd., of States Airport, Jersey, Channel Islands: Application No. 2265 for a U.K. Internal Service initially with Heron and Bristol 170 aircraft and later also with DC3 and/or Viscount and/or Herald and/or Friendship aircraft for the carriage of passengers, supplementary freight and mail on the route Manchester and/or Liverpool (Speke) and/or Bristol and/or Cardiff - Jersey and/or Guernsey at an initial frequency of one return flight daily increasing later in accordance with traffic demand from November, 1958, until the resumption of operations by Cambrian Airways, Ltd.

THESE applications will be considered by the Council under the Terms of Reference issued to them by the Minister of Civil Aviation on 30th July, 1952. Any representations or objections with regard to these applications must be made in writing stating the reasons and must reach the Council within 14 days of the date of this advertisement, addressed to the Secretary, Air Transport Advisory Council, 3 Dean's Yard, London, S.W.1, from whom further details of the applications may be obtained. When an objection is made to an application by another air transport company on the grounds that they are applying to operate the route or part of route in question, their application, if not already submitted to the Council, should reach them within the period allowed for the making of representations or objections. [8405

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B.Sc.(Eng.), Ph.D., M.I.E.E., M.I.Mech.E.,

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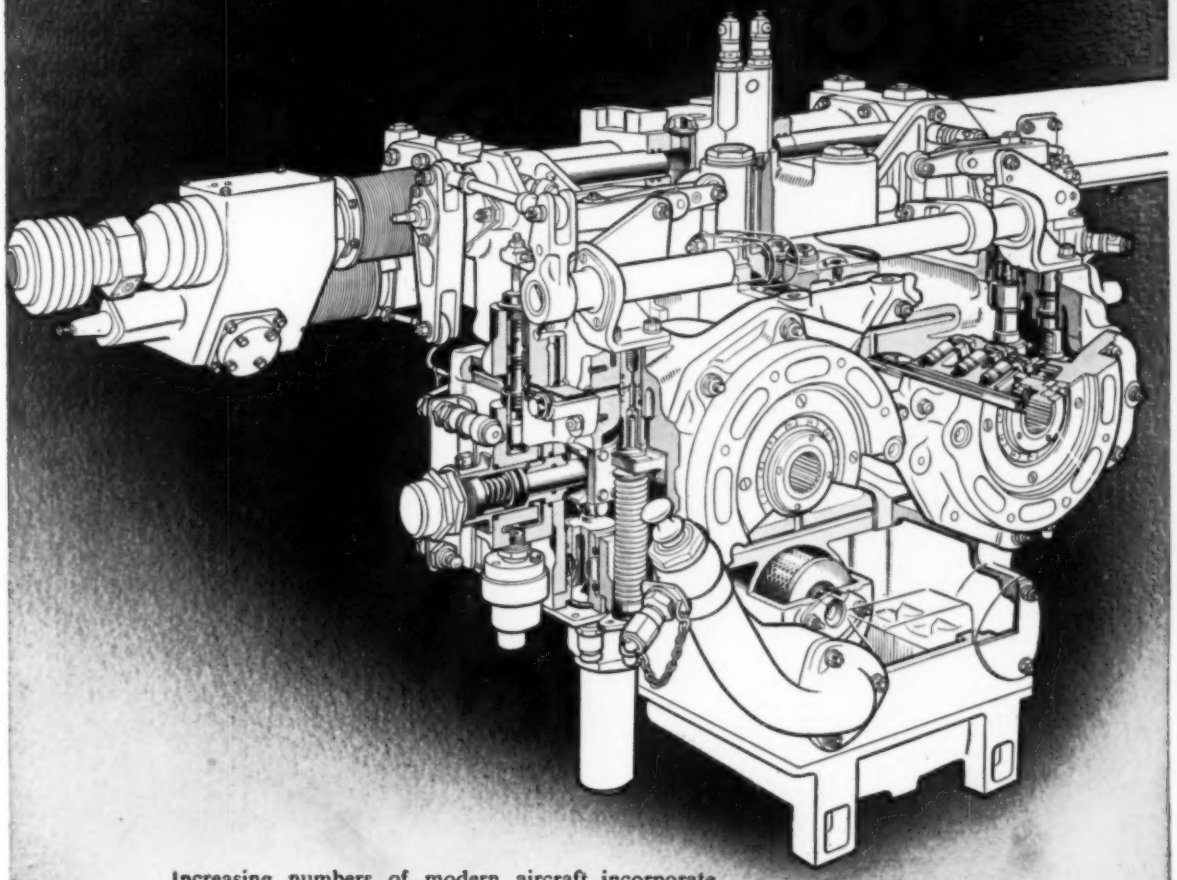

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London—Singapore	29 hrs 45 mins	37 hrs 30 mins	7 hrs 45 mins	20·7%
Tel Aviv—New York	22 hrs	27 hrs	5 hrs	18·5%
London—Chicago	15 hrs 20 mins	18 hrs 20 mins	3 hrs	16·4%
London—New York	10 hrs 50 mins	13 hrs 35 mins	2 hrs 45 mins	20·2%
New York—London	9 hrs 15 mins	10 hrs 45 mins	1 hr 30 mins	13·9%
New York—Mexico City	6 hrs 30 mins	7 hrs 45 mins	1 hr 15 mins	16·1%
Vancouver—Amsterdam	13 hrs 30 mins	19 hrs 30 mins	6 hrs	30·7%